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ALL ABOUT IT:

OR,

THE HISTORY AND MYSTERY

OF

COMMON THINGS.

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CHILDREN'S ROOM

THE
HISTORY AND MYSTERY OF COMMON THINGS.

About Tea, Coffee, etc.

What is Tea?

The leaves of a shrub grown chiefly in China and Japan; of which countries it is a native. It is an evergreen, grows to the height of from four to six feet, and bears pretty white flowers, resembling wild roses.

Is there more than one species of the Tea Plant?

Yes, several; those most cultivated are the *Thea bohea* and *Thea viridis;* it was formerly believed that these two plants produced the black and green teas, and from this belief they derived their names; but it is now proved that the difference arises in the mode of preparation, and either kind of tea can be made from either plant without any difficulty.

How is the Tea Plant cultivated?

In China there are great numbers of tea-farms, generally of small extent, situated on the upper valleys, and on the sloping sides of the hills, where the soil is light and rich, and well drained. The plants are raised from seed, and generally allowed to remain three years before a crop of leaves is taken from them, as this operation of course injures their growth; even with care, they become stunted, and unprofitable in about eight or ten years. When the crop is ready, the leaves are carefully picked by hand one by one, and there are usually three or four gatherings in each year, the first crop in the spring being of the most value; a well-grown bush, well treated, will produce two or three pounds of tea annually.

How is the Tea prepared for use?

For green tea, the leaves are only allowed to dry for an hour or two after gathering, before they are thrown into heated roasting-pans placed over a wood fire; they are stirred quickly with the hands, and allowed to remain for a few minutes; they are next rolled by hand on a table covered with mats, and afterward roasted and rolled again; the color is by this time set, and the after-processes of sorting and refiring, which, for the finer sorts, are repeated several times, may be deferred till a leisure time. In the preparation of Black Tea, the leaves are allowed to remain a long time, say a whole day, drying, before they are fired; they are tossed about and patted whilst cooling, and are finally dried over a much slower fire.

How do the Chinese use Tea?

They drink it pure; generally a handful of tea is put into a china basin or cup, and boiling water poured over it, which is renewed three or four times, till all the strength is gone; sometimes they add salt and ginger, and sometimes sugar, but not often. Tea-shops are very common by the road-sides, and the road in front of them is usually thatched over, that those who stop for a cup of tea may be shaded from the sun.

How is the Tea sent from the farms to the coast for exportation?

Mostly by coolies, who carry the chests over the mountains till they reach some navigable river or canal, by which it can be conveyed to the coast. It is said to be a curious sight to watch, from the top of a wild mountain pass, long trains of coolies laden with chests of tea, which they carry on their shoulders or balanced at each end of a bamboo, winding along in one direction; and others returning laden with cotton goods and other merchandise received in exchange.

Is Tea cultivated anywhere but in China and Japan?

Yes, it has recently been introduced into some parts of North America, and also into the high valleys of the Himalaya range, where it appears likely to thrive.

When was Tea first brought to Europe?

In 1610, by the Dutch East India Company; and it must have been in use in England by the year 1660, as appears from an Act of Parliament passed in that year, in which a tax of 1s. 6d. was laid on every gallon of tea sold at the coffee-houses. There is also the following entry in Pepys' Diary, dated September 25th, 1661: "I did send for a cup of tea (a China drink), of which I had never drunk before." In six years more it had found its way into his own house, as this entry shows: "Home—found my wife making of tea, a drink which Mr. Pelling the potticary tells her is good for her cold," etc. About this time the East India Company ordered "one hundred pounds weight of goode tey" to be sent home on speculation. The price was about fifty or sixty shillings the pound; and two pounds three ounces of the best tea was not deemed an unfitting present from the East India Company to the king. But so greatly has the exportation increased, that now more than fifty thousand tons of shipping are employed in its transportation, while it is consumed at the present moment by probably not less than five hundred millions of men. Still, so vast is the home consumption, that it is alleged that, were Europeans and Americans to abandon its use altogether, the price would not be much diminished in China.

What is the effect of Tea upon the human system?

That of a mild narcotic; and when taken in small quantities, exhilarating. Of all narcotics, tea is the least pernicious, if indeed it be so in any degree. It acts likewise as a diuretic, and powerfully assists digestion.

What are the chemical substances of Tea?

In manufactured tea there exist a volatile oil, *theine*, *tannin*, and *gluten*. Every hundred pounds of tea yield about one pound of a volatile oil, about two per cent. of theine, and eighteen or twenty per cent. of tannin, while gluten forms about one-fourth of the weight of the dry leaves, a very small proportion of which, however, is extracted by the water in which the leaves are infused. To obviate this waste of nutrition, it has been suggested that a pinch of soda should be thrown into the water along with the tea.

What is Theine?

A white, bitter crystallizable substance, having the composition of an alkaloid, containing a very large proportion of nitrogen. It serves an important office, when taken into the system in small quantities, of sensibly diminishing the wastes of the body, and lessening the necessity for the consumption of food. It consequently renders tea, with the aged, the infirm, and all whose powers of digestion are impaired, a valuable auxiliary of nature, by which the wear and tear of the solid tissues are supplied, even while the stomach is unable to make up for the natural wastes of the body, by the digestion of ordinary food.

What is Tannin?

A peculiar vegetable principle, so called because it is the effective agent in the conversion of skin into leather. The barks of almost all trees contain it. If an infusion of tea be poured into a solution of glue, the solution becomes turbid, and a grayish precipitate indicates the presence of tannin. To this tannic acid tea owes its astringent taste, while it probably contributes to the exhilarating effect which tea produces.

What is Coffee?

The seed of an evergreen shrub, the *Coffea Arabica*, which is said to have been discovered in Abyssinia by the Arabs.

Where is it chiefly cultivated?

In Arabia, the Southern states of North America, Costa Rica, Brazil, and other tropical parts of South America, the East and West Indies, Java, and Ceylon; but the climate of Arabia, where it was first cultivated, appears most suited to its growth; frequent rains, and the brilliant unshaded light of its almost cloudless sky, stimulate vegetation, and cause the secretion of those principles on which depends the delicate aroma.

Will you describe a Coffee Plantation?

Elevated situations are most suitable for the growth of coffee, and the plantations have much the appearance of pleasure-grounds; the trees are raised from slips, which are allowed four or five years to grow before they are cropped; they attain the height of eight or ten feet, and continue in bearing about from thirty to fifty years. The shrub or tree resembles a handsome laurel, and bears a profusion of clusters of fragrant white flowers, which are succeeded by brilliant red berries, sweet and pulpy, which ripen to a purple color—each contains two coffee-seeds or stones.

Does the crop require much care?

Nothing but pruning the trees and picking the berries; after they are gathered, they are pulped in a mill formed for the purpose, by which the beans, as they are called, are deprived of the surrounding pulp and outer skin. In a second mill they are peeled of their inner skin and winnowed; they are then dried in the sun on large open clay floors, picked over by hand, and finally packed in bags or barrels to be exported.

How is the Coffee rendered fit for use?

The beans are roasted, in a close revolving cylinder, over a clear but moderate fire; they should afterward be cooled quickly by exposure to the air, and then ground in a covered mill; the sooner the infusion is made after roasting and grinding the finer will be the flavor of the coffee. The flavor of coffee depends, in a great measure, upon the skill and care exercised in roasting it. If too little roasted, it is devoid of flavor; if too much, it becomes acrid, and has a disagreeable, burnt taste. Coffee, as commonly prepared, is boiled for some time, under the mistaken notion that its strength is not extracted unless it be boiled. But the fact is just the reverse. The fine aromatic oil, which produces the flavor and strength of coffee, is dispelled and lost by boiling, and a mucilage is extracted at the same time, which also tends to make it flat and weak.

Which is the best mode?

To pour boiling water through the coffee in a strainer, which plan is found to extract nearly all the strength; or, to pour boiling water upon it, and to set it upon the fire, not to exceed ten minutes. The Turks and Arabs boil their coffee, it is true, but they boil each cup by itself, and only for a moment, so that it is more of the character of an infusion than a decoction. The best coffee in Europe is made in France. In England and the United States coffee is almost always badly made. Experience has proved that Asiatic coffee is superior to all others; whether this arises from their mode of roasting, or because they pound the beans, and do not grind them, is uncertain.

What is the nature of Coffee?

It is a powerful stimulant and cordial. In faintness, exhaustion from labor or fatigue, and from sickness, coffee is one of the most cordial and delicious restoratives. M. Payen shows that coffee contains the maximum of aroma, weight and nutrition. He declares it to be very nutritious, as it contains a large quantity of azote; three times as much nutriment as tea; and more than twice the nourishment of soup (*bouillon.*)

When was Coffee first used in England?

In the early part of the seventeenth century, probably a little before tea was introduced, as that beverage is first spoken of as being sold at the coffee-houses; it is said that the first coffee-house keeper in London was a Greek servant, named Pasqua, brought to England by a Turkish merchant to make his coffee. It appears to have been first used as a drink at Aden, thence introduced into Egypt, and thence into Turkey, where it is still very much in use. Dr. Livingstone, the African traveller, mentions that the coffee-tree was taken by the Jesuit missionaries to the western coast of Africa, where it has since become naturalized, and covers vast spaces of waste land. Many sermons against coffee-drinking are extant, written at the time when it was introduced into Europe; as there are also many sermons against smoking. We recollect having read the following passage in an old sermon:—"They cannot wait until the smoke of the infernal regions surround them, but encompass themselves with smoke of their own accord, and drink a poison which God made black, that it might bear the devil's color."

What is Cocoa?

The bruised seed of various species of *theobroma*, a tree which grows wild in the West India Islands, Brazil, and various parts of Central America, where it is generally found growing at the height of six hundred feet above the level of the sea.

What is the tree like?

The cocoa, or, as it should be written, *cacao*-tree, is an evergreen, and is said to bear some resemblance to a young cherry-tree; the leaves are large and simple, the flowers grow in clusters, the pods are not unlike cucumbers in form, and of a yellowish-red color; they contain from twenty to thirty nuts, about the size of large almonds, violet or ash-gray colored, and containing each two lobes of a brownish hue.

How is the Cacao cultivated?

A wet soil is needful, and the plants also requiring shade, they are generally placed between rows of large trees, which render the plantations very charming spots in tropical regions; the plants are raised from seed, and are seven or eight years in coming to perfection, but require so little attention that one man can superintend one thousand plants; the usual times of gathering the crop are in June and December, and not more than one pound and a half of seeds is the average produce of each plant. The fruit of the wild plants is frequently gathered.

What is needful to prepare the Cacao for market?

The seeds, after being freed from the pod, are dried either in the sun or by artificial heat; they are then either simply bruised, which makes cocoa-nibs, or crushed between rollers, which makes flake cocoa; or they are ground and made into a paste, in which state they are very often adulterated.

How is Chocolate made?

The cacao-beans are gently roasted, shelled, and reduced to a paste, when vanilla, cloves, cinnamon, rice, almonds, or starch, etc., are frequently added to it; it is put into moulds, and always improves by keeping.

Why is it called chocolate?

From *chocolatl*, the Mexican name for the cacao-tree. The produce of several of the finest kinds is not exported; the best that reaches us is from Caraccas, Guatemala, and Berbice.

What is Chiccory?

The chiccory which is used to mix with coffee is the dried root of the *Cichorium intybus*, a smallish plant which bears a beautiful blue flower of the composite form. The root is in form like a carrot, and from the crown spread a number of large succulent leaves. The seed should be sown in April, in rich light soil; the crop is ready in September; the roots being taken up, washed, and cut into pieces two or three inches long, are dried in a slow oven or kiln; they are afterward cut into much smaller pieces, and roasted and ground just like coffee. It is much more esteemed in France and Germany than with us.

Are there any other substitutes for coffee than chiccory?

Numerous ones. In some parts of Germany the juniper-berry, used for imparting the peculiar flavor to Holland gin, is roasted, ground, and infused as a substitute for coffee. In some of the western portions of our own country it is not uncommon to use the grains of the Indian corn for the same purpose. Upon the continent of Europe the roasted acorn affords a decoction under the name of acorn-coffee. The carrot and turnip are employed as substitutes; and so also peas, beans, rye, and other grains, nuts, almonds, and even wheaten bread.

What is Sherbet?

An acid, perfumed drink employed in Turkey and Persia, composed of water, lemon-juice, and sugar, sometimes with perfumed cakes dissolved in it, or with drops of rose-water to render it agreeable.

About Fruit.

Where are Oranges grown? I know they are imported, where do they come from?

The orange-tree, *Citrus aurantium*, grows abundantly in almost all the warm soft climates of southern Europe, northern Africa, and many temperate parts of Asia and America. Those consumed in the Northern states are brought from the islands of the Atlantic and the Southern states. St. Michael, one of the Azores, is famed for producing the most favored kind.

How are they grown? Describe the orange-gardens for me.

They are surrounded by high walls, not only to protect the trees from depredators, but from high winds, which often do serious damage; notwithstanding this precaution, many of the trees are blown down, either from the weight of the fruit with which they are loaded, or from some other cause. The orange-trees are usually branched almost, if not quite, from the ground; their leaves are evergreen, and their flowers white and very elegant; they yield a delicious perfume, sweet and almost luscious, yet one that does not cloy. On many trees the flowers and ripe fruit hang together; and, when thus loaded—the fruit, some of light green color, others of a pale yellow, others of a deep orange, and all set off by the deep glossy green foliage—the trees are superb.

How is the crop prepared for exportation?

The fruit is gathered in December, or even earlier, a little while before it is ripe; and large baskets being filled by boys who take them from the gatherers, they are carried away at once to the packers, who most commonly sit in groups on the grass; the oranges are poured out in a heap with as little concern as if they were coals; each orange is wrapped in a husk of Indian corn; these are prepared by children, who hand them to a man, who wraps up the orange and passes it to another, who places it in the chest; this is all done with amazing rapidity. The box is filled to overflowing, thin boards are bent over it by a carpenter, and secured with willow bands, and then it is ready to be carried to the port and shipped.

What tree yields the Lemon?

The lemon-tree, *Citrus Medica*, a native of Assyria and Persia, whence it was brought first to Greece, and afterward to Italy, Portugal, and France; it is also frequent in our greenhouses. It is a small and beautiful evergreen, with numerous branches and bright shining leaves; the flowers, which are white and very sweet, are larger than those of the orange, and bloom the greater part of summer; they are succeeded by the pale golden fruit.

From what countries are Lemons brought?

Lemons are brought from Spain and Portugal, and also from the West Indies; but the latter chiefly supply *limes*, which are the produce of the *Citrus aeris*. They are smaller than the lemon, of an oval shape, thinner in the rind, and, though as acid, rather milder in flavor. Citrons are the fruit of another tree nearly allied to these; they are less acid, but the rind has a hot and bitter taste, and, when candied, it is much used for flavoring cakes and puddings. Citrons are imported, both preserved and candied, chiefly from Madeira. Another species of citrus yields the scent known as bergamot, which is an essential oil distilled from the rind of its pear-shaped fruit.

What are Shaddocks?

Shaddocks are a variety of the *Citrus*, and are among the largest fruits which are known. They are commonly cultivated both in the East and West Indies, for the sake of the delicate subacid juicy pulp in which they abound. When arrived at their greatest size they are called pompoleons.

What are Figs.

The fruit of the *Ficus carica*, which is a native of Asia, but was early imported into Europe; it flourishes in France, Spain, Italy, and even ripens its fruit in this country. The first fig-trees introduced into England are still in the archbishop's garden at Lambeth; they are supposed to have been planted by Cardinal Pole; they now bear excellent fruit. The greater part of the figs come from the shores of the Levant. The figs, when ripe, are dried in ovens, and packed in boxes and small baskets for exportation. The fig-tree seldom grows more than twelve feet high, but is very spreading, and bears large lobed leaves, which are annual in Europe, and perennial between the tropics.

What is the name of the tree which yields Olives?

The *Olea Europea*, which grows abundantly in all the countries bordering on the Mediterranean Sea. The olive-tree grows upon the most rocky calcareous soils, seldom exceeds twenty feet in height, but is much branched and spreading; it lives to a great age, and increases very much in bulk, so that one tree may easily, at a little distance, be mistaken for a group. There is an olive-tree at Pescio seven hundred years old, and twenty-five feet in circumference.

Did not Olives grow abundantly in Judea?

Yes, they were abundant there, and there are some still standing in the garden of Gethsemane, which are so large and old they are thought to have been in existence ever since the time of our Saviour. Josephus tells us that when Titus destroyed Jerusalem, he cut down all the trees within one hundred furlongs of the city; still it is very probable that these trees may have grown up from the roots of the old ones, because it is quite a characteristic of the olive-tree to shoot up again, however frequently it may be cut down. They are wild olives of extreme old age, their stems quite rough and gnarled.

What are the trees like?

The leaves are evergreen, stiffish, and pointed; the flowers white, growing in clusters, succeeded by an oval *drupe*, or plum, which is violet-colored when ripe, bitter and nauseous.

The preserved olives, common as a table luxury, are the unripe fruit pickled in a strong solution of salt.

Is not salad-oil made from Olives? How is it made?

The ripe fruit is gathered in November, and bruised in a mill, the stones of which are set so wide apart as not to crush the nut or kernel; the pulp is then gently pressed in bags made of rushes; the first oil that flows is of the most value; a second quality is obtained by breaking the refuse, mixing it with warm water, and returning it to the press; and after this a third very inferior kind is obtained.

Where do Pomegranates come from?

The pomegranate-tree, *Punica granatum*, is a native of the south of Europe, Asia, and Barbary; but in the West Indies, where it has been introduced from Europe, its fruit is larger and better-flavored than in its native climates. Where the tree thrives, it rises twenty feet high, throwing out branches even from the bottom; the leaves are pointed, and of light brilliant green; both the calyx and corolla are of a bright red color, the latter is the most brilliant.

What is the fruit like?

The pomegranate is a pulpy, many-seeded berry of the size of an orange, globular, covered with a thick coriaceous rind, and crowned with the calyx, which is sharply thorned. The red succulent pulp is pleasantly acid, and was made into wine by the ancients.

What are Cocoa-Nuts?

The fruit of the *Cocos nucifera*, or cocoa-nut palm, a lofty and elegant palm-tree which grows abundantly in most tropical countries; it is from fifty to sixty feet in height, its simple column-like stem being crowned with a beautiful plume of feathery leaves from twelve to fourteen feet long. The nuts grow in several long clusters, depending from the base of the leaves; they are about the size of a man's head, the thin outer rind covering a large mass of fibres, which are used in many countries for making mats, cordage, and coarse sail-cloth. Within this fibrous coating is the shell of the nut, which is oval and very hard, and often serves for a drinking-cup. The kernel is firm, white, and pleasant; the interior hollow, and filled with sweet milky juice; when unripe, it is entirely filled with this juice.

What is the Date?

The date is the fruit of a tall and graceful palm, *Phœnix dactylifera*, which shoots up a single straight stem to the height of fifty or sixty feet, and then expands into a beautiful crown of leaves. It is abundant in Barbary, Arabia, Persia, and the adjacent countries, particularly on the confines of the deserts and in the oases. The fruit somewhat resembles a plum, but is rather longer in proportion; it contains a long oblong kernel, grooved on one side. The pulp is soft, sweet, and slightly astringent; it is rich in sugar, gum, and other vegetable matter, affording the most wholesome nutriment.

Are not Dates an important article of food to the inhabitants of those countries where they are abundant?

Yes; in many places they form the staple food, and the crop of dates is as anxiously expected as our wheat harvest, or the vintage of southern Europe. The fruit, when gathered quite ripe, is often pressed into large baskets, and thus forms a hard solid cake called "adjoue," which is afterward cut up and sold by the pound. Date-stones are soaked in water, and given to the cattle.

Where do Almonds come from?

From Spain and Italy; but they grow spontaneously in many other warm countries. The almond-tree, *Amygdalus communis*, greatly resembles the peach in growth, leaves, and blossoms; it flowers in the early spring, and produces fruit in August. The fruit is covered with a tough skin, and is enclosed in a rough shell. There are two kinds of almonds, the sweet and the bitter; only differing from each other in the flavor of the nut. Valentia almonds are sweet and large; Italian not either so large or sweet; Jordan almonds come from Malaga; they are long, and not very pointed, and are the best kind imported; the bitter almonds come chiefly from Mogadore, on the northern coast of Africa.

What are Brazil-Nuts?

They are the produce of the Juvia, *Bertholletia excelsa*, a lofty and magnificent tree, abounding on the banks of the Orinoco and the northern parts of Brazil. The nuts, which are triangular and covered with a hard rough shell, are contained to the number sometimes of fifty in a woody outer shell, which is often as large as a child's head; it is divided into six compartments. They are highly prized by the natives, and largely exported.

What are Pistachio-Nuts?

Nuts brought to us from Sicily and Syria, where they grow upon a kind of turpentine-tree. They are oblong and pointed, about the size and shape of a filbert, including a kernel of a pale greenish color. Their taste is very agreeable.

What are Filberts, to which you allude

The common hazel is the wild and the filbert the cultivated state of the same tree. The filbert is larger than the common nut, and has a larger kernel. They are very free from oil, disagree with few people, and are highly esteemed at the dessert.

What are Raisins?

They are dried grapes, prepared either by cutting the stalk of the bunches half through when they are nearly ripe, and leaving them on the vine till the sun dries and candies them, or else they are gathered when fully ripe, dipped in a lye made of vinewood-ashes, and dried in the sun. Inferior kinds are dried in ovens. Raisins are chiefly imported from Spain, Turkey, and Italy. Of these the ones from Smyrna are the least esteemed, and those from Malaga the most. The finest of the Malaga raisins are those made from the Muscatel grape. Fresh grapes are also imported from Spain and Portugal, packed in jars with sawdust.

What are Currants?

They are a smaller species of grape, dried in a similar manner to the raisins. The currant-vines are much cultivated in the Ionian Isles, especially Cephalonia and Zante; also in the Morea. They are even said to derive their name from Corinth, where they are abundant. Of late years some disease has attacked the currant-vines, the crops have very much fallen off, and the Greek cultivators were almost ruined; but an improvement has since taken place.

What are Prunes?

Prunes and French Plums are dried plums imported from France; in the southern parts of which country all kinds of plums grow abundantly. The common sorts are packed in baskets; but the finer sorts, intended for table-fruit, are carefully gathered and dried, and packed in small elegant boxes, which are ornamented in various ways with the characteristic good taste of the French. The preparation of these boxes gives employment to a great number of persons.

What are Pine-Apples, and whence do we obtain them?

The pine-apple, *Bromelia ananas*, is a tropical fruit of fine flavor and very luscious. The plant consists of a few leaves round a stalk, then the soft, pulpy, juicy pine covered over with conical excrescences, and surmounted by a crest of stiff prickly leaves. It is often cultivated in our hothouses, as well as imported from the West Indies, and other tropical countries.

What are Tamarinds?

The preserved fruit of the *Tamarindus Indica*, which is a native both of the East and West Indies, and probably of most parts of Arabia and Africa. It is a large forest-tree, and affords excellent timber, hard, heavy, and durable; the leaves are pinnate, like those of the mountain-ash, and of brilliant green. The pods grow in bunches of five or six, they contain from three to six glossy seeds, and are filled with a stringy pulp. In the West Indies the ripe pods are gathered and packed into a cask. which is then filled up with hot syrup; in the East Indies they are preserved without sugar. The pod of the variety which is found in the East is about double the size of those which grow in the new world.

What are Cranberries?

The fruit of a very pretty little trailing plant which grows wild in this country; and which is so abundant in Russia, Norway, and Sweden, that large quantities of the ripe fruit are exported packed in hogsheads. The English cranberry, *Oxycoccus palustris*, has slender thread-like woody stems, tiny leaves, and a pink flower, the five petals of which are turned back; the fruit is a round austere red berry, which is very pleasant when cooked or made into marmalade. The American cranberry, *Oxycoccus macrocarpus*, is much larger in leaf, fruit, and flower, and the flavor is more medicinal. The Russian crop of these little berries is not gathered until the snow is gone; and near St. Petersburg they are so abundant that the snow is said to be stained red by the cranberries crushed in the passage of sledges over them.

What are Barberries?

A small red fruit, *Berberis vulgaris*, which grows in the woods and hedges. The fruit is acid, and extremely astringent, but is cooling, and in the form of jellies or conserves, both refreshing and strengthening to the stomach. The flowers are small and beautiful, and at the first appearance resemble in perfume the cowslip.

What is the Apricot?

Upon the authority of Pliny and others, the apricot is a native of Armenia, whence its present Latin name *Armeniaca vulgaris*. It is allied to the plum, of an oval shape, and most delicious in taste. It is multiplied by budding either upon the common plum or the muscle plum. The tree comes early into bloom, and flourishes best against a high wall, or in the proximity of a warm chimney.

What is the Nectarine?

A fruit resembling the peach, but with a smooth rind. It is a native of Persia, and was introduced into Europe from that country in the year 1562. The mode of cultivation is almost identical with that pursued with the peach, with which it is usually classified.

What is the Banana?

A variety of the plantain, *Musa sapientum*, of a highly grateful flavor, and comprising an extremely nutritive and healthy aliment. The form of the fruit resembles the cucumber. It is asserted "that no individual plant in the vegetable kingdom produces so much nutriment in the same space of ground." It is relished by all ranks of people in the West Indies, and is generally considered in those hot climates as superior to bread. Some or other of the plants are in bearing the whole year round. It is eaten raw, roasted, or boiled, and is made with fritters, preserves, and marmalades; and it is dried in the sun, and preserved like figs. The plantain is allied to the banana, but it is a native of the old world, being carried to the West Indies from India and Africa.

What is the Papaw?

The papaw grows on a branchless tree in the East and West Indies; the size is that of an ordinary melon, and in form it resembles a gourd. The fruit is somewhat acrid and unpalatable, but, when boiled, is eaten with meat like other vegetables.

Is there not a fruit of the same name which grows in portions of North America?

The North American papaw grows upon the rich bottom lands of our Southern and Western rivers. It belongs to the genus *Annona;* in shape it is not much unlike the banana; the color is orange, and it contains a yellowish pulp of the consistence of custard. The flavor is so excessively luscious, that a little serves to cloy the palate.

There are still several kinds of fruit which you have not described. What are Guava and Jujube?

The best guava, known as the white guava, is grown in the West Indies. The fruit is about the size of a hen's egg, yellow, smooth, and has a fragrant but peculiar odor; the pulp is sweet, aromatic, in the form of a jelly, and is considered one of our finest conserves. The jujube, ***Zizyphus vulgaris***, is a native of Syria, whence it was introduced into Europe. It is found, however, in the greatest perfection in China. It is also grown extensively in Turkey, the Turks planting the tree around their coffee-houses, that they may enjoy both the shade and the fruit. In Italy and Spain it is a favorite fruit as a dessert, and is used for this purpose, both fresh and dried, as a sweetmeat.

What other varieties of fruit do you recall?

The durion, ***Durio Zibithinus***, an Asiatic fruit which grows upon a lofty tree. Some of the fruits are nearly as large as a man's head. It is very nutritious, and both scarce and highly prized in its native country. The Chinese Litchi, a small round fruit, covered with a tough leathery coat, with a colorless semitransparent pulp, is very agreeable in flavor. It is exported in a dried state. The Mammee, ***Mammea Americana***, a native of the West Indies. The tree grows to the height of seventy feet, with a spreading and elegant head, which is compared with that of the magnolia. The flowers are odoriferous. The fruit is large, yellow in color, and very fragrant and delicious. It is eaten both raw and cooked, and is sometimes cut in slices and dipped in wine or sugar. Still another West India fruit is the Alligator or Avocado Pear, one of the most delicious of fruits, with a yellow pulp superior in delicate flavor to the peach.

What is the Mango?

The mango ranks in general estimation as one of the finest of the tropical fruits. It resembles the banana, but is somewhat shorter and thicker. It has a thin skin, and on removing this, the interior is described to consist of "a pulp, which melts in the mouth with a cooling sweetness, and a delicious aromatic and sub-acidulous taste." The mangos of Asia are said to excel those of America. The ripe fruit is exceedingly perishable, and cannot be brought to this country; the green is made into jellies and conserves. The wood of the mango, among the Hindoos, is consecrated to the service of the dead, and is used almost exclusively for coffins or the funeral pyre. It is of a whitish-gray color, porous, yet, if kept dry, very durable. The tree sometimes grows to a great size, with an erect trunk, and dark-colored cracked bark.

About Spice.

Whence do we derive our Spices?

All spices are the product of tropical climates only. No native plant possesses sufficient aromatic flavor to be included among the spices. The most valuable of these aromatics, so highly prized by all nations, came originally from the Spice Islands, or Moluccas, situated in the Indian Ocean.

Which are the chief Spices?

Cinnamon, cloves, pepper, ginger, pimento, nutmegs, and mace.

What is Cinnamon?

The bark of a small tree, the *Cinnamomum Zeylanicum*, which, as its name imports, is a native of Ceylon, and chiefly cultivated there, though it is raised also in Java. The tree is very graceful; the leaves, which are red in spring, become thick, leathery, and glossy green as the summer advances; they are netted with raised veins on the under side, and are placed opposite each other on the stem; the flowers are greenish white, and grow in small loose clusters at the termination of the branches.

Does the cultivation need much care?

The trees require a rich, light soil, and also shade; they are therefore planted in open glades of the forest, where a few large timber trees remain to shelter them; this greatly contributes to the beauty of the cinnamon harvest, when the natives assemble to strip the bark: their graceful figures and bright-colored clothing forming picturesque groups in the forest glades, and the whole air being loaded with the scent of the spice. Cinnamon peeling begins in May, at the end of the rains, and lasts till November. The peeling simply consists in slitting the bark and cutting it across, so as to turn it back; it is then soaked to remove the outer rind, and rolled up into quills about three feet long, and is then fit for exportation. Cinnamon has a warm, pleasant aromatic taste, and is slightly astringent. It contains volatile oil, tannin, mucilage, a vegeto-animal coloring matter, an acid, and a woody fibre.

What are Cloves?

They are the flower-buds of a tree gathered before they open, and dried in the sun; the round ball is the corolla surrounding the stamens, &c., and the shaft is the calyx tube. The odor of cloves is strong but agreeable, the taste very aromatic and warm; the name is said to be derived from the French "clou," a carpenter's nail, which they are thought to resemble. Cloves contain an essential oil of very great pungency, in which their efficiency consists, gum, resin and a woody fibre.

What is the name of the tree which produces Cloves?

The *Caryophillus aromaticus*, a small evergreen with long shining leaves, and short terminal bunches of sweet-scented flowers; it is a native of the Molucca Islands, where it was originally discovered by the Portuguese, in 1511, and whence it has been taken to almost every tropical country. A tree twelve years old will yield from five to twenty pounds of cloves annually; when older, perhaps sixty pounds, and as a single stem may live one hundred and fifty years, the produce is almost incredible. Sir Stamford Raffles describes the clove as "a tree of noble height, somewhat like the bay, and composing, by the beauty of their forms, the luxuriance of their foliage, and the spicy fragrance with which they perfume the air, some of the most delightful objects in the world." The Dutch, when in possession of the Spice Islands, endeavored to secure a monopoly of cloves, and they bribed the native chiefs to cut down all the clove-trees in the islands, with the exception of those in the island of Amboyna, to which they designed to confine their cultivation. In pursuance of this scheme military detachments even now visit the islands every year, and cut down the young trees, which grow up with astonishing rapidity. But notwithstanding the plans of the Dutch, cloves have been introduced into other parts of the world.

What are Nutmegs and Mace?

They are the produce of a tree, the ***Myristica moschata***, which is a native of the Moluccas, and is cultivated both in those islands and in Java, Sumatra, and the West Indies. The fruit of this tree resembles a peach in size and shape; when ripe it readily splits into two parts, showing the kernel or nutmeg surrounded by the mace in the form of a sheath.

When is the fruit gathered?

There are generally three gatherings in a summer, the first in July or August; the last, which yields the best crop, in April. The mace is red when gathered, but in drying becomes yellow; on removing the mace a shell is found, inside which is the nutmeg. The nutmegs when gathered are sorted, and dipped into lime-water to preserve them from insects.

What is Pepper?

Pepper is the fruit of a climbing or creeping plant called *Piper nigrum*, which has alternate leaves, jointed stems, and spikes of naked flowers; the berry is small, round, and fleshy. This plant grows abundantly in Sumatra, Java, Borneo, and the Malay Peninsula. The pepper vines, as they are called, are trained to trees and shrubs, and are allowed to grow four years without gathering the crop; this takes place while the berries are still green, before they are ripe, and they are dried quickly on mats in the sun, which turn.

them black, therefore it is called Black Pepper; White Pepper is produced by soaking the berries till the outer skin peels off readily.

What is Long Pepper?

The fruit of the *Piper longum*, also a native of the East Indies; in long pepper the spike and half-ripe berries are all dried together, which makes it resemble the catkins of the birch: the flavor is like that of black pepper.

What is Cayenne Pepper?

The dried and ground fruit of the *Capsicum*, a genus of plants related to the woody nightshade; these fruits are fleshy, and bright scarlet or orange, very pungent, and much used in flavoring both in their unprepared state and ground.

Is there more than one kind of Capsicum?

There are two principal species, *Capsicum annuum*, a plant which grows wild in South America and the West Indies; and the far hotter *Capsicum fruiticosum* of the East Indies, a shrub which bears much smaller fruit. Capsicums are very useful to the inhabitants of hot climates, rousing the digestive organs when impaired by the great heat; even birds and animals have recourse to them, and have been known to die when deprived of them, for want of the stimulus to which they have been accustomed.

Does Pepper aid the digestive powers of the stomach?

It promotes the secretion of the gastric juice, but to those of inflammatory habits it is hurtful. The analysis of pepper shows it to contain starch, malic, a volatile oil, and a peculiar substance called pipirina. The oil of pepper is too pungent for the tongue; applied to the skin it inflames it immediately.

What is Chili Vinegar?

Vinegar in which capsicums have been steeped, till it is thoroughly impregnated with their flavor.

What is Ginger?

The root stock of the *Zingiber officinalis*, the narrow-leaved or common ginger: a plant with grass-like leaves, and spikes of irregularly formed flowers; it is a native of the mountain of Gingi, in Hindostan, whence the name, but grows in most tropical countries. The largest proportion of that consumed is cultivated in the West Indies. When cuttings are planted out in spring, in three or four months they have acquired a mild aromatic flavor, and are fit to make preserved ginger, but for the ginger of commerce they must be at least one year old.

How is the root prepared?

It is prepared either by scalding, peeling, and drying in an oven, in which case it is called Black Ginger, or by simply peeling and drying in the sun, which is called White Ginger. Ginger is stimulating, and less hurtful than pepper; it is found, upon analysis, to consist chiefly of starch, although it contains a volatile oil, acetic acid, potash, gum, and sulphur.

What are Cardamoms?

The aromatic capsules of various species of *Amomum*, a plant related to the *Zingiber*, all the species of which are splendid plants, remarkable for the beauty and richness of their flowers. Cardamoms come chiefly from Malabar, Madagascar, and Sumatra; they are warm aromatics, and are much used in the east to flavor rice and other insipid food; in England they are also used in medicine.

What is Pimento?

Pimento, or Jamaica pepper, otherwise called allspice, is a warm spice grown in the West Indies; like black pepper, it is a small berry gathered unripe and dried in the sun, but it grows on a handsome tree that reaches to the height of about twenty feet, the *Eugenia pimenta*. As an aromatic stimulant, pimento is less expensive than the oriental spices, and as it contains the flavor of cinnamon, nutmeg, and cloves, hence its popular name of allspice. It is an agreeable aromatic, more mild and innocent than the common spices. The best pimento is from Jamaica, where the tree grows spontaneously, the seeds, it is supposed, being sown by birds.

What are Capers?

The flower-buds of the *Capparis spinosa*, a native of the south of Europe, where it grows all over the rocks and ruins, decorating them with its showy blossoms; which are large and white with a long tassel of lilac stamens springing from the centre of each. The flower-buds have a sharp, acrid taste; their quality depends on their age, the youngest being of the most value; each bush yields about a pound of capers annually.

What are Caraways?

They are the seeds of an umbelliferous plant, the *Carum carui*; it is a biennial with finely divided aromatic leaves, small white flowers, and a root like a little carrot. Caraways have a warm, spice-like taste, and are used in medicine as well as by confectioners and brewers.

About China, Porcelain, etc.

I noticed when I broke that China cup what a beautiful white substance it appeared inside; how was it made?

That beautiful white piece of china, like all other kinds of earthenware, was originally a lump of clay; it was moulded into the form in which you saw it, and then baked and glazed afterward.

What is the difference between China, or Porcelain, and Earthenware?

All kinds of pottery, from the finest to the coarsest, are composed of two ingredients, clay and flint baked together; but in porcelain these are of such kinds and in such proportions that the product is a semivitrified compound, in which one portion remains unaltered by the intensest heat, while the other vitrifies or becomes glass, and, enveloping the particles of the infusible ingredient, produces the smooth, compact, shining, semitransparent substance we call porcelain.

How are the materials prepared?

The first part is the preparation of the clay. That from which English porcelain is composed is mostly found in Cornwall, Devonshire, and Dorsetshire. The clay from the first-named place, which is considered the finest, consists of decomposed felspar of granite, which is the rock most abounding in that county. The clay merchants prepare it by the following method, and send it to the potters under the name of china clay. The stone is broken up, and laid in running water, the clayey, or, as they are called, argillaceous parts, being the lightest, are carried off in suspension, while the quartz and mica, which were united with them in the granite, fall soon to the bottom. At some distance these rivulets end in catch-pools where the water is arrested, and after time has been allowed for the pure clay with which it was charged to settle and form a deposit, it is drawn off, and the clay dug out in square blocks, which are placed on shelves to dry in the air. It is now a hard white mass, which can by crushing be reduced to an impalpable powder.

Will you describe the process of manufacture?

The lumps of clay are first pounded and mixed with water to the consistence of cream, by means of various beating and cutting implements; the pulp is then strained through several sieves, each one finer than the last. The next process is preparing the flints, which are first burnt in a kiln and thrown, red-hot, into cold water, and afterward ground in water to an impalpable powder; the two dilutions of clay and flint are then brought together, stirred very thoroughly, and again strained; and so great is the affinity between them that, even when wet, they unite and form a mortar which no action of the atmosphere can decompose. This fluid mixture is called "slip," and is gradually evaporated in what are called "slip-kilns" to a consistence like dough.

Is it then in a state fit for moulding into different articles?

No, it leaves the slip-kiln full of air-bubbles, which must be worked out by elaborate treading and kneading, generally with the naked feet, and after this is done, it should be left a long while before it is used, that the two elements may the more intimately unite. If placed in a damp cellar, the blocks of slip undergo a kind of fermentation, by which all traces of animal or vegetable matter which they may have contained are decomposed and got rid of; and this greatly improves its quality. So sensible are the Chinese of this that they extend the interval over fifteen or twenty years, and a parent will often provide a sufficient stock for his son's life.

How are the vessels shaped?

There are three modes in use—throwing, pressing, and casting; throwing is performed on a kind of lathe, which consists in a contrivance by which a small circular board revolves very rapidly, and on this the clay is measured, and its intended shape given to it, by the pressure of the fingers and palms of the potter's hands. This instrument is the *potter's wheel*, which is of the highest antiquity, being apparently as old as the art itself; nor does its form and mode of use seem to have undergone much change during these long ages. In the catacombs of Thebes in Egypt, which have been proved to have existed nineteen hundred years before Christ, there have been discovered paintings representing various processes of the potter's art, and among these is a delineation of a potter's wheel, identical in principle with those now in use. The clay vessel thus moulded is then partially dried before transferring it to the turning-lathe, where it is reduced by sharp tools to the required thickness, and its form carefully finished off; it next passes to a man who applies handles, spouts, and all other small appendages; these are fastened on with slip; all these small, irregular-shaped pieces are made by pressing in moulds formed of plaster of Paris; and plates, saucers, and other shallow vessels, are formed in a mould, which is made to revolve on the block of the lathe, and into which the workman presses the clay with his hand.

You said the vessels were baked; are they put into an oven or a furnace like bricks?

They are put into a furnace enclosed in deep clay boxes called *seggars*, capable of sustaining the most intense heat; these protect the ware from the flame and smoke; the process of baking lasts from forty-eight to fifty hours, the heat gradually increasing; trial pieces are placed where they can easily be abstracted to see how the process goes on, and when it is finished, the fires are put out, and all is left undisturbed twenty or thirty hours to cool.

I have heard china jars called biscuit; what are they?

Bisque or biscuit is the name given to the ware after its first baking. It is so called from its resemblance to ship-bread. Many small vases, figures, and other articles of ornament are sold in this stage. The ware is afterward glazed by being dipped in a compound of litharge of lead and ground flints, glass, or some similar ingredients, mixed with water to the consistency of thin cream. The workman employed stands by a large tub or other reservoir, and, taking up the pieces of ware so that the smallest possible portion shall be covered by the fingers, he dexterously plunges it in, taking care that the glaze is equally distributed all over the article; it then passes to a woman, who scrapes off any superfluous glaze adhering to it. A skilful workman will dip about seven hundred dozen plates in a day. It is worthy of remark that the glaze, when applied, is perfectly opaque, so that any painting or printing with which the article may have been ornamented is not visible until it has been fired. This second baking is done in a gloss oven; the heat converts the flint, etc., into a thin coating of glass.

What more is needful after glazing?

The next operation is painting, which requires to be done with peculiar metallic colors, united to a flux; these colors are moistened with gum-water or a peculiar oil, which causes them to adhere to the surface of the china until it is subjected to a slight firing, sufficient to fuse the glass or flint with which the colors are united: the paintings are thus burnt in, and acquire a gloss equal to the rest of the surface. Professed artists are employed for ornamenting china in this manner, and the most exquisite designs are frequently produced. For the common ware a much simpler process suffices, and this is done *before* the glazing instead of *after* it, as is the case with the painting. The pattern is printed from a copper-plate, on a thin paper, and this is transferred to the ware in the state of biscuit, when the color remains and the paper is removed; the glazing then proceeds as before noted. Gold is applied to the finer wares in a metallic state, and after burning on, requires burnishing with agate or blood-stone.

Whence have come the names China and Porcelain?

China, from the country whence specimens of the manufacture were first brought to Europe; and porcelain, from *porcellana*, the Portuguese for a little cup—the first traders in the article having been of that nation. In Anderson's "History of Commerce" we learn that the first porcelain brought to England was in a Portuguese ship taken as a prize in 1593. Its beauty soon caused it to be in great request among the great and wealthy; and the emulation of artists to imitate it was soon excited.

Does the Chinese method of manufacture differ from the European?

Not materially; the earths which they use, *kao-lin*, a soft substance full of glittering particles, and *pe-tun-tse*, which is brilliantly white, fine, and soft, bear the same relation to each other that English clay and flint do; indeed, the china clay of Cornwall, the most valuable of the English earths, is proved to be identical with the kao-lin of the Chinese. They form their vessels in the same way, but fire them only once, subjecting them however to far more intense heat, as many of their glazes would not vitrify at a lower heat than would suffice to fuse Cornish granite.

Where is the Chinese manufacture principally carried on?

In the town of King-te-ching, where immense multitudes are employed in it. Father Entrecolles, a French missionary who resided in China in the early part of the last century, has given many interesting particulars of this manufactory, which appears to have been quite as large and active then as now; three thousand ovens were then to be seen at work at once, giving to the town the appearance of one great furnace. Some idea of the antiquity of the art in China may be obtained from the fact that small china flasks with inscriptions in Chinese characters, differing little if at all from those in use in the present day, have been found in some of the tombs of Thebes; thus appearing to prove not only that the Chinese possessed at that early date the art they have so long been celebrated for, but also that they knew and traded with the Egyptians. It has been shown that the Egyptians were potters themselves; and many little figures covered with a fine deep-blue glaze are found deposited with their mummies, which may either have been made by themselves or obtained in trade from the Chinese or Phœnicians; nor were these the only nations of antiquity who practised this art; it seems to have been more widely spread than most others, and there are few nations removed one step from barbarism who have not made for themselves drinking and cooking utensils of rude pottery.

Is not Chinese Porcelain ornamented in a very queer style?

Yes; and the division of labor being great among them, and carried even into their designs, different workmen, without any concert or plan, paint successive parts of the same group or picture, which contributes to the grotesque effect of their work; the effect is also heightened by their ignorance of perspective. They make, beside common china, several others: a black kind, much esteemed in the East; a kind which appears as though it were cracked all over; one in which the colors show only when the vessel is filled with liquid; and still another variety, in which various figures appear raised on pure white porcelain, and yet the surface is perfectly smooth. The great durability of Chinese ware is shown by the porcelain tower at Nankin, which is nearly three hundred feet high, and entirely covered with porcelain tiles; and which, though it has now stood four hundred years, appears not to have suffered in the least from the action of the air and weather.

You say that the Chinese were, by many centuries, the first who made fine porcelain—when was the manufacture begun in Europe?

The first attempt is supposed to have been made by the Moors in Spain; then a large manufactory was established in the Balearic Isles, which ware was called *Majolica*, from Majorca, the largest of those isles. This manufacture was afterward removed to Italy, where many improvements took place; but these articles were all made of coarse brownish paste, the imperfections of which were hid by an opaque glaze, instead of the material being perfectly white and the glaze transparent, as is the case with good foreign and modern European ware. This Majolica ware was the most esteemed from the middle of the fourteenth to the middle of the sixteenth centuries, when came the epoch of Bernard Palissy in France. His long-enduring patience under trials and disappointments of every description, till he almost ruined himself in his attempts to discover a new and more perfect enamel glaze, in which he was finally successful, have almost passed into a proverb. Palissy was a Protestant, and died in the Bastile, where he was imprisoned for publicly advocating his opinions.

Was there no manufacture of China in England during all this time?

Only a rough and common earthenware, but about the latter part of the seventeenth century began that improvement which has led to the production of our common household china. First it was discovered that salt thrown on the articles heated in the furnace covered them with a rough glaze; then two German brothers of the name of Ellers settled in Staffordshire, and discovered there a bed of very superior clay; and after this, a gentleman named Astbury, who was engaged in the manufacture, having occasion to employ some calcined flints as a poultice for his horse's eyes, noticed their fine white opaque substance, and added them to the paste of which he made his china—thus supplying the last needed ingredient for the perfection of the art. The next and greatest improver was Josiah Wedgewood, who was born a poor potter's son, but who raised himself to wealth and eminence by his genius and industry; he devoted himself quite as much to improving the style and ornamentation of his works as to their material, and entirely altered the character of the manufacture.

Meanwhile on the continent a similar progress was being made; after many unsuccessful efforts, about the commencement of the eighteenth century, a German alchymist named Botticher, made some crucibles which the fire converted into true porcelain; and afterward discovering a fine white clay, he established a manufactory at Dresden, which was the origin of the celebrated Dresden china. The discovering of the clay for this famous ware was singular. John Schnorr, a wealthy iron-master, riding near Clue, found that his horse's feet were sticking in a soft, white earth, and his attention being thus directed to this white earth, it occurred to him that it would make a first-rate substitute for flour as hair-powder. To that use he turned it, therefore, with much profit to himself, under the name of "Schnorr's white earth." Botticher was among those who used it, and observing its earthy nature, tested it, and found to his great joy that this was just the thing to perfect his porcelain. The Elector then caused the earth to be taken to the factory in sealed barrels, under conditions of the utmost secrecy. The manufactory at Meissen now became a fortress; the portcullis was down day and night. Every workman was sworn to secrecy:

the superior officers were sworn every month. "Dumb till death" was inscribed in large letters within all the workshops, and imprisonment for life the penalty denounced against all tale-bearing. The king himself took oath of secrecy concerning all that he might see whenever he visited the factory. For there was in trade the age of mysteries before the age of patents. This discovery was followed by the far-famed works of Sèvres, the earlier wares of which factory were actually made entirely of artificial compost, without any of the real ingredients of china represented by the Chinese *kao-lin* and *pe-tun-tse*. This porcelain, from its shining white, its beautiful glazing and colored grounds, holds at present the very first rank. In the magnificence of its gilding, and the regularity and elegance of its forms, it surpasses every other kind of china; vases, and other objects of the most exquisite beauty, are made from it, but their great cost renders them beyond the means of all except the most wealthy.

What is Plaster of Paris?

A composition of gypsum, dug at Mont Martre, near Paris. The plaster-stone, or alabaster, is however, found in some parts of England. It is used by potters to form moulds for their vessels; by figure-makers to form copies of statues; as also by artists to form the basis of artificial marbles, different colors being given by the addition of colored powder.

What is Gypsum?

Sulphate of lime, a mineral found in a compact crystallized state, as alabaster or selenite, or in the form of a soft chalky stone, which, by being heated, becomes the white powder known as plaster of Paris. The operation of burning is usually performed at night, that the workers may be the better able to see when the mass is red-hot, at which time it becomes sufficiently burned. After burning, it is ground in a mill.

The purer semitransparent specimens of gypsum are used for ornamental works in vases, urns, etc., and in statuary;

for which purposes its softness makes it very useful, and easy to work. But another and very important use of gypsum, or plaster, as it is usually called, is for manuring grass and grain lands; in which case it is invaluable. It is almost incalculable how great an additional quantity of grass will be obtained by the sprinkling a peck of ground plaster upon the acre of land. It is one of the cheapest and best manures for grass or grain that can readily be procured.

About Glass.

What is Glass, and of what is it made?

Glass is a transparent, hard, brittle substance, formed by the fusion of flint or sand and an alkali; generally soda, though for the finer sorts of glass potash is used. It is remarkable that though so perfectly transparent itself, none of the ingredients employed in the manufacture of glass possess that quality; and also, that an article which is brittle to a proverb, should, when heated, become so exceedingly ductile as to be capable of being moulded into any and every form that may be desired, and drawn out into the finest thread.

Is Glass of as great antiquity as China?

Probably not quite; Pliny attributes the discovery of glass to some Phœnicians who were driven ashore near the mouth of the river Belus, and lighting a fire with kali, a plant which grew there abundantly, they noticed that the sand, when mingled with the ashes of this plant, melted into a vitreous substance. Whether we credit this account or not, it is certain that the sand on that particular shore was well suited for the glass manufacture which afterward sprang up in that neighborhood.

Where was Glass made in the earlier ages?

Tyre and Sidon were the cities first noted for its manufacture; but the tombs of the Egyptians, which have preserved so many of the secrets of that ancient people, contain in some cases paintings of glass blowers at work; and glass beads, and gems of the same material are found among the relics. De Pauw is of opinion, that the Egyptians carried the art to the highest perfection; and that the glass-works at Diospolis, capital of the Thebaid, formed the first regular manufactory of this material. The Egyptians, according to the same author, performed the most difficult operations in glass-cutting, and manufactured cups of glass of an astonishing purity, of which kind were those called *alassontes*, supposed to be ornamented with figures in changeable colors. Winckelmann says that the ancients in general made much greater use of glass than the moderns. In the ruins of Herculaneum glass utensils have been found in great numbers. Some blocks of glass, used for paving rooms, have been found of the thickness of an ordinary brick. Winckelmann cites some specimens of mosaic of remarkable beauty and delicacy; one of them represented a bird on a dark and colored ground. The colors of the bird were brilliant, and the whole effect soft. The artist had made use of opaque or transparent glass, according to the necessities of the case, and what was not the least remarkable was, that the reverse offered precisely the same figure, without the slightest difference in the details. A little glass ring in the specimen which was in the possession of Sir W. Hamilton, showed the method in which this was performed. The exterior of the ring was blue, and the interior represented a species of rose, of different colors extending the whole circuit of the ring. As melted glass may be drawn out into an amazingly fine line, this operation may be performed on pieces of glass, composed of different colors, and melted, the tints preserving the respective layers when wire drawn.

In later times Alexandria was for a long time the source from which Rome was supplied with drinking-vessels, and large urns for purposes of interment; it was succeeded by Venice, which exported mirrors and glass vessels to the whole civilized world. The most celebrated specimen of antique glass is the Portland vase, which was found in the tomb of Alexander Severus, who died in the year 235; the vase is of deep-blue glass, the figures, in bas-relief, are of opaque white, and exquisitely cut. It is worthy of remark, that the Chinese, though so skilful in the kindred art of porcelain-making, understand nothing about glass-working for the purpose of making vessels for drinking, or other useful articles; they succeed admirably, however, in the production of glass imitations of various precious stones, and other small ornaments; they frequently use old European glass to remelt, and work into these articles.

Was the Glass made at Venice very beautiful?

Yes; in many respects it was as good as that now made, and the Venetians produced many curious varieties, the manufacture of which was, until late years, considered a lost art. The glass-makers of Murano, a small island adjacent to Venice, were considered gentlemen in right of their profession, and a curious old letter, dated "Venice, the 1st of June, 1621," mentioning this circumstance, adds, "and it is not without reason, it being a rare kind of knowledge and chymistry to transmute the dull bodies of dust and sand, for they are the only main ingredients, to such a diaphanous, pellucid, dainty bodie as we see cristall glasse is, which hath this property above gold and silver or any other mineral, to endure *no poyson.* Glasse also hath this rare qualitie, that it never loseth anything of its first substance and weight, though used never so frequently and so long. It is wonderfull to see what diversitie of shapes and strange formes those curious artists will make in glasse, as I saw a compleat gallie with all her masts, sayles, cables, tackling, prow, poope, forecastle, anchors, with the longboat, all made out in cristall glasse, as allso a man in armour." The belief here alluded to, that

Venetian glass drinking-vessels would break if poison was put into them, was common until a much later period.

When was Glass first used for windows?

It is said to have been used so early as the fifth or sixth century in some of the churches of Italy; but it was not till the eleventh that glass windows were seen in England; and their predecessors, the wooden shutter and the strained linen cloth, or paper soaked in oil, continued to be used two or three centuries longer by the common people; so late as the year 1567, we find in an account of a survey of Alnwick Castle, a recommendation that the glass windows should be taken out and laid up when "his lordshippe was not there, because throwe extream windes the glasses of the windowes dooth decay and waste, and the decay thereof shall be verie costlie and chargeable to be repayed."

How many kinds of Glass are made?

Five; flint glass, or crystal; crown glass; broad sheet glass; bottle, or green glass; and plate glass. Each of these kinds is made with silex and alkali; their different qualities being dependent on the proportions and degree of purity of these ingredients, and on various accessory materials; such as nitre, oxide of lead, of manganese, or of arsenic; borax, or chalk. Formerly silex was sometimes used in the form of ground flint, now this is discontinued, and sea sand is almost always employed.

How is Glass made?

For all kinds of glass, except flint, the materials, after being purified, are put into a furnace called a "calcar," where they are "calcined," this process is called *fritting*; the substance comes out soft and pasty, and is cut into squares which harden, and are piled away for future use. In the final melting, the *frit* is put into glass-pots, or crucibles, about twelve of which stand in each furnace; these crucibles sometimes hold as much as a ton of glass each, and are reached by openings in the wall of the furnace.

Does the Glass become transparent as soon as it is melted?

Not immediately, a white opaque porous scum, known by the name of sandiver or glass gall, rises to the surface, and till this is all cleared off the glass is not transparent; this scum, which appears to consist of salts and refuse alkali, is purchased by refiners of metals, who use it as a flux.

How is the molten Glass fashioned into the different articles?

It is cooled till it becomes a consistent tenacious mass, soft enough to yield to the slightest pressure, able to be bent and pulled into any shape without cracking. All kinds of small articles are made of flint glass; and to form these the workman then takes his blowpipe, collects a quantity of melted glass upon the end of it, and having rolled it upon a polished iron slab, called a *marver*, blows through the pipe, thus distending the glass into a hollow globe; this is repeated, the glass being frequently heated at the opening in the furnace, till it assumes the desired size; it is then transferred from the blowpipe to another rod, and the workman, with an instrument like a pair of sugar-tongs, bends, contracts, or enlarges the vessel; any excess of material is cut away with shears as readily as a bit of soft leather. One other tool completes the number used in all the ordinary processes, this is a small flat iron plate with a handle, and is called a battledore, it is used to flatten the bottoms of tumblers, jugs, etc.

What is done with the vessels when completely formed?

They are at once carried to the annealing oven called a *lear*, where they are heated and allowed to cool very gradually, without which precaution they would be liable to break with the slightest touch or change of temperature. The reason for this is, that crystalline substances expand with heat and contract in cooling, and as the degree of expansion exactly agrees with the degree of heat, any thing like a tube or hollow vessel, which cools more slowly inside than outside, is very liable to be broken by the consequent derangement of the atoms—some being crushed by the unequal tension. The cure lies in placing the articles in such external heat as shall allow both surfaces to cool at the same rate. The larger and heavier the glass is the more difficult will it be to cool it safely. A curious proof of the qualities of unannealed glass is given in the Rupert's drops, which are small lumps of green glass dropped red-hot into cold water, they have thus the form of rounded lumps diminishing to a tail; the round part may be roughly treated without danger, but if the smallest particle of the tail be broken the whole thing bursts into countless fragments, and so violent is the explosion that a stout glass vessel would be broken by it. The annealing oven, or *lear*, is an arch with a furnace at one end, which is heated by coke, and which has a door at each end; this oven is very long, often sixty feet, but narrow, the floor is fitted with pans for receiving the glasses, which travel slowly on a miniature railroad from the hottest to the coolest end; the time employed for annealing varies, according to the size and weight of the articles, from six to sixty hours.

How are sheets of Crown Glass, like those used for cutting into window-panes, made?

The melted glass is collected on the blowpipe, as in the case of flint glass, and the workman gradually blows a globe, he then fastens on an iron rod to the side opposite that where the blowpipe is inserted and takes the latter away, which leaves a hole, he heats the glass again and begins twirling the rod, the glass yields to the impulse, its diameter increases, and it finally flies out into a flat disc fifty to sixty inches across, and having the rod attached in the centre by a lump of glass commonly known as a bull's eye.

How is Plate Glass made?

Great care is taken in the selection of such materials as will insure the greatest clearness and most ready flowing of the glass; these are fused in the ordinary manner, and afterward removed from the large glass-pots to smaller ones, also kept in the furnace, and from these the fluid glass is poured out on large flat iron tables constructed for the purpose; the tables are heated before being used; and a large copper roller is passed over the sheet of glass: as soon as it is set it is carefully removed into the annealing oven, where it remains about fifteen days.

Are the plates of glass then ready for use?

They are then what is termed rough plate, which is frequently used where great strength is more needed than transparency, but to finish the plate glass it must be squared, ground, and polished; the grinding is performed by making a plate steady in a frame, and then causing another to rub steadily backward and forward upon it, with some grinding substance introduced between them; this is at first ground flint, and afterward, as the roughness is lessened, emery powder is used; when perfectly smooth they are polished with leather cushions dressed with a red oxide of iron called *colcothar.*

How are the plates of glass converted into mirrors, or looking-glasses?

A flat smooth slab of wood or stone, enclosed in a wooden frame and fixed on a pivot, is adjusted horizontally; a sheet of gray paper is then stretched over it, and above this another of very thin tinfoil, and as much mercury is poured on as will rest on its flat surface; the plate of glass is then very carefully slid into the frame and deposited on the foil, and considerable weights are applied to its surface, which squeeze out the superfluous mercury; at the end of a day the under side of the glass is found to be covered with a thin soft amalgam of mercury and tin, which hardens by exposure, and causes the glass accurately to reflect.

Are these glass mirrors the same kind as those we read of in the Old Testament?

No, the first mirrors, and those which were in use for many ages, were simply discs of some hard metal; often of brass, or an alloy of tin and copper, but sometimes of silver, which were very highly polished, and set in some kind of ornamental frame; of this kind were the looking-glasses of the women mentioned in Exodus, chapter xxxviii. verse 8, out of which Moses made the brazen laver for the tabernacle.

What are meant by Paste Gems?

Imitations of jewels made in a very hard and clear kind of glass; some of these imitations are very beautiful, and hardly to be distinguished by sight from the stones they are made to imitate.

For this purpose the glass must be colored—must it not?—how is this effected?

Most of the colors used for tinting glass are obtained from oxides of various metals, which are mixed in suitable proportions with the fluid glass; the depth of the color depends on the quantity of oxide. Formerly hyacinth, hock, and finger glasses, etc., were formed out of solid colored glass; but the modern practice is, to case the white flint-glass, of which the vessel is to be formed, with a thin coating of very highly-colored glass, which has a far lighter and more brilliant effect. The following is a list of the principal colors employed, and the oxides which produce them:

Transparent blue . .	Oxide of cobalt.
Azure blue . . .	Oxide of copper.
Ruby red	Oxide of gold.
Amethyst, or purple .	Oxide of manganese.
Common orange . .	Iron ore and manganese.
Emerald green . .	Copper and iron.
Gold topaz color . .	Oxide of uranium.

Beside these, opaque white enamel is often introduced, which is made by the addition of a small proportion of arsenic and antimony, or, for a harder kind, by adding putty prepared from tin and lead.

Are not some countries more celebrated for making ornamental glass than either England or the United States?

Yes, Bohemia and France are both noted for their beautiful productions in the glass manufacture; but we are fast following in their track, and England already surpasses them in the purity of its white crystal glass. The Bohemians followed the Venetians in many curious methods of ornamenting glass; one, which was chiefly used for stems of drinking-glasses, was to enclose in the colorless transparent glass small white and colored tubes, the whole mass being afterward heated and twisted, so that the substance of the stem seemed composed of spiral threads of different colors. Another plan, and one which has now become common in all glass-producing countries, is to coat the whole glass with a case of colored glass, and then cut the pattern through the outer coat; thus leaving a white indented pattern on a colored ground. Beside these, there is frosted glass, which is produced by plunging the ball of glass attached to the blowing-rod into cold water, the glass being almost at a white heat; this kind of glass is irregularly veined with marble-like projecting dislocations and intervening fissures.

How is glass ground and cut?

The implements used are very simple—they are principally circular discs not exceeding twelve inches in diameter, set in motion by machinery; against the circumference of these discs the glass is held by the workman: The thickness and form of the cutting edge varies of course with every description of work to be done, and the material for the cutting disc is cast-iron; sand and water are allowed to drip on its surface during the operation; the rough sand-marks are then ground out on a stone wheel, and the glass is polished on a wooden or cork wheel; the latter even in some instances covered with hat-felt to make its touch softer. These polishing-discs are dressed with emery, pumice-stone, or putty powder. Glass engraving is a beautiful and, to some extent, a modern mode of ornamenting; for though the Greeks, Romans, and Venetians understood engraving simply on the surface of the glass, and cameo-cutting or raised figures in relief on the surface, the Bohemians were the first who engraved arabesque borders, landscapes, animals, etc., in polished relief on a rough ground; this art has been known among them for perhaps two centuries. This kind of engraving is performed with copper wheels and fine emery, the common foot-lathe being more useful than one turned by steam-power as little force is needed, and it is important that the velocity be varied and checked at pleasure.

How are Glass Beads made?

A number of small glass tubes of different colors are first made; these are then cut into very small pieces; they are afterward shaken up with a mixture of sand and ashes, which fills up the small holes, and prevents their closing during the next operation, which is a slight fusing; in order to smooth the rough edges after this, they are cleared and strung by children.

How is Glass stained for Gothic church windows?

Painting upon glass had its origin in the third century, and soon became much used to ornament windows in churches, and in unison with the style of Gothic churches, throw a subdued tint over the whole interior. There were two modes of staining or painting glass for this purpose; one painting behind the glass, the tints and designs showing through the transparent substance; another making use only of colored varnishes, or transparent colors. The art derived great advantages at the end of the fourteenth century from the important invention of enamel painting, or the art of fixing the metallic colors in glass. The art flourished most in the fifteenth and sixteenth centuries.

Is not the ancient art of glass-painting lost?

No, although an ignorant impression exists to that effect. In modern times glass-painting has been carried to great perfection in Munich. Modern art can produce the effects of light and shadow, harmonize and mix colors, and fix them as permanently by enamelling and burning, as the ancients could.

What are Enamels?

Substances of the nature of glass, differing from it by being more fusible; they have for their basis a white transparent gloss, and are composed by melting the oxide of tin with glass, and adding a small quantity of manganese to increase the brilliancy of the color. The addition of the oxide of lead produces a yellow enamel; reds are formed by the intermixture of the oxides of gold and iron.

What is Enamelling?

The art of variegating with colors laid upon or in another body; also a mode of painting with vitrified colors on gold, silver, copper, and other metals; and of melting these at a fire. There are two modes of enamelling—the transparent and the opaque. By the first mode, previous to the application of the enamel, patterns and devices are cut with the graver, and these reflect through the richly tinted enamels, with which they are afterward encrusted. In opaque enamelling the enamel is first broken into small pieces, then ground, spread evenly on a plate of copper, and poured through a furnace, when the enamel melts, and adheres firmly to the metal. This forms the enamel plate; the figures or designs are painted on the enamel in vitrifiable colors, and the work is again subjected to the heat of the furnace, which, melting the color and softening the enamel at the same time, incorporates the two into one body, and this permanently fixes the painting. Paintings in enamel are frequently exposed to the heat of the furnace ten or twelve times before completed. The cost of producing them is great; but their durable nature renders them for many purposes invaluable. The largest work that has been executed in enamel is the "Bacchus and Ariadne" after Titian. The size is sixteen and a half by eighteen inches; it was sold for twenty-two hundred guineas. The art has recently been turned to a very useful purpose, in enamelling the interior of saucepans and other culinary and domestic articles. The security which these articles afford against any metallic taint, not to speak of their superior cleanliness, renders them peculiarly valuable. The enamel with which these vessels are coated is composed of silica, borax, soda, and potter's clay.

About Salt, etc.

What is Salt?

Salt in its popular sense is a crystalline mineral substance, white and sparkling, with a sharp pungent taste; and is used to cure and season many articles of food. Common salt is not altered in its composition by heating it to a red heat; it is not soluble in spirit; and, which is remarkable, hot water scarcely dissolves a larger portion than cold; crystals of salt, therefore, cannot be obtained by cooling a solution of it, but by evaporation. The natural form of the crystals of salt is a cube, but when formed at a high temperature they are deposited much more rapidly, and are hollow pyramids.

Where is Salt found?

Salt being one of the necessaries of life, we find it by the kind care of Providence stored up in every land; every nation has access to it either in the form of salt springs or mines, or can obtain it from the sea. These sources form "the inexhaustible storehouses of our household salt--all that we employ in our fisheries, in our meat-curing establishments, in our agriculture, in our soda manufactories—all that fuses our glass, and fertilizes our fields, imparts the detergent quality to our soap, and gives us salt herrings and salt pork; and every thing else salt that is the better for being so, down to our dinner celery and our breakfast eggs."

Are there Salt-works in England?

There are springs of salt in Cheshire and Worcestershire, and also mines of rock-salt.

Are the Worcestershire Salt-works ancient?

Yes; there were salt-works in Droitwich in the time of the Romans, and they have been continued ever since that time;

in the days of the heptarchy one of the kings of Mercia gave ten salt furnaces in Droitwich to the church of Worcester; and these springs, which were employed in making salt almost two thousand years ago, still flow on, supplying salt at the rate of one thousand tons each weekly, with no diminution in their volume or their degree of saturation. The *rock*-salt of Cheshire has only been worked since 1670, when it was discovered in searching for coal.

How is the Salt prepared from the brine springs?

The brine is pumped by steam power into reservoirs in which are placed pieces of rock-salt, that no fuel may be wasted by evaporating an unsaturated solution; from these reservoirs it is drawn off as wanted into evaporating pans; these are made of wrought iron; they are shallow and oblong, and contain from six hundred to one thousand superficial feet; there are three or four fires to each pan. The various kinds of salt are produced by the different degrees of temperature at which the water is evaporated and the crystals formed; the less heat is applied the larger the crystals are. The time occupied varies from twelve hours employed in making stove-salt to five or six days needful to make large-grained or fishery-salt; when the crystals are formed at the bottom of the pan they are raked out and heaped up in conical baskets to drain.

Where is Rock-Salt obtained?

Beside the rock-salt found in England, salt mines have been discovered in Austria, Hungary, Russia, the Tyrol, Sweden, and many other parts of Europe; the principal of these are the mines of Bocknia and Wieliczka, belonging to the Austrian government. They were originally worked in the year 1250, and were carried on in a very rude manner for five hundred years.

Can you describe these mines?

The mine of Wieliczka measures with all its galleries thirty, English miles, its greatest depth is one hundred and forty-five fathoms; it is divided into three distinct compartments, called fields; each of these consists of five stories one below the other, and each story is made up of numerous chambers, cells, and caverns, connected by passages; the descent is made by staircases and shafts; the staircases are carved in rock-salt, and are some of them very magnificent, no dirt or disorder is visible anywhere; and as there are no springs of water at so great a depth, the air is quite dry, and every thing is kept in the most perfect state of preservation; there is a strong current of fresh air through the passages, and noxious gases are never met with in salt mines.

Are the excavated chambers large in this Mine?

Yes; many of them are one hundred or one hundred and fifty feet high, and eighty or one hundred feet long and wide; some are used as storehouses, and others as chapels, ball-rooms, and dining-halls on occasions of festivity. In the chapels every thing is carved out of rock-salt; altars, walls, ceilings, doors, crucifixes, niches, pedestals, and statues upon them; all solid, and yet so translucent that a torch held behind one of the statues shows light through its thickest part; and all sparkling and glittering as with countless diamonds.

How are these halls formed?

They are left in the process of excavation, and where any addition is required it is built with salt and water; in this manner, masses of salt are piled one upon another, and water is thrown over them, which dissolves a portion of the salt; the crevices are thus filled up, the water evaporates and leaves the whole a solid mass; columns of salt are always left to support the roof.

What other means are used to get Salt?

In some mines the chambers after excavation are flooded with fresh water, which, after remaining several months to get saturated, is drawn off and evaporated in the usual manner. In other places, where weak brine springs occur, the solution is allowed to drip over compact bundles of faggots, or to trickle down ropes; by which means it is much exposed to the air, and part of the water is economically evaporated before boiling commences. When sea water is used for making salt it is always exposed to the sun in shallow ponds until the quantity is very much reduced.

Is Rock-Salt ever found on the surface, or always at a great depth?

In Russia, Persia, Abyssinia, and many other countries, salt deserts occur; tracts of land where salt is so abundant, both on the surface and beneath it, that it can be obtained with little more trouble than collecting it; these tracts are quite barren, and after a shower are covered with a white incrustation of salt resembling a fall of snow. At Cardona, in Spain, the rock-salt appears on the surface, and even forms a precipice four or five hundred feet high, overlooking the valley; this is quarried as any ordinary rock might be, and the salt is so pure as to need only grinding to fit it for use.

How is this country supplied with Salt?

No rock-salt has been worked here yet; but brine springs are abundant, which are termed "licks," from the fact of their being frequented by deer, buffaloes, and other wild animals, for the sake of the salt incrustations which they greedily devour.

What are the uses of Salt?

As an article of food, it is essential to the health of mankind, forming a constituent of the blood; those nations who obtain it with difficulty suffer much in consequence of the deprivation. At one time a heavy duty of fifteen shillings per bushel was laid on it in England, which made it an expensive article; this has been repealed, and now it is not only cheap as an article of food, but is extensively used in agriculture and manufactures.

Of what is Salt a symbol in the East?

Of fidelity; a man who has partaken of salt with you is bound to you by the laws of hospitality; and thus bread and salt are eaten at the ratification of a bargain or treaty, to make it binding on all parties. Salt is also an emblem of desolation: conquered cities were sown with salt.

Were there any customs connected with Salt in other countries?

In Scotland and Ireland salt appears to have been considered to represent the incorruptible spirit; and was therefore laid above the heart of a corpse; and in some cases a platter was so placed containing a small portion of salt and earth unmixed, the one to represent the immortal, the other the mortal part. In former days, when it was the custom for all the household of a nobleman or gentleman to dine together, the large salt-cellar which was placed in the middle of the table was the boundary of distinction between the family and the menials.

What is Soda?

An alkali which was formerly obtained in large quantities from the ashes of kali and various other marine plants growing on the shores of the Mediterranean Sea, and to which ashes the name of barilla is given; a more impure soda was obtained from kelp, which is the ashes of different sea-weeds found on the coasts of Ireland and Scotland; a large trade was formerly carried on in these articles, but it is now found cheaper to make soda by the decomposition of salt.

How is this accomplished?

The salt is put into a furnace, and sulphuric acid poured upon it; the heat first melts it, and then roasts it into sulphate of soda, or *salt-cake*, as it is called; this is afterward put into another furnace with an equal weight of carbonate of lime, either in the form of limestone or chalk, and half its weight of small coal; the whole is subjected to intense heat, during which many chemical changes take place. The mass, when finally raked out to cool, consists of black-ash and ball soda, or British barilla; it is afterward separated from insoluble impurities by being dissolved in warm water; and, after being further purified in the furnace, becomes the soda of commerce, which is in fact carbonate of soda.

What is the chief use of Soda?

It is employed for many things on account of its cleansing qualities, but the largest consumption of it is in the manufacture of soap and glass; in common with the other alkalies, it forms soap by union with fatty substances; and glass, by union with flinty ones.

Why are they called alkalies, and what does the name come from?

They are so called from *kali*, the name of the plant which yields one kind, and which is said to be of Arabic origin, and to signify "the dregs of bitterness."

What is Potash?

An alkali obtained by burning woods; it is afterward purified, and is very similar in its nature and uses to soda. Pearlash is potash further purified.

What is Soap?

A compound formed by the union of an unctuous substance and an alkali. Soaps are of two kinds, hard and soft, differing from each other in the materials used in their manufacture; and in the uses to which they are applied; the latter kind being chiefly used in the cleansing of stuffs and silks. Hard soaps are made from animal fats, or vegetable fat oils, and soda; soft soaps of fish oil or vegetable drying oils, and potash; soda soaps are invariably harder than potash soaps, when the oleaginous substance is the same. Soap purifies only by virtue of its alkali, part of which combines with the greasy matter to be removed by washing.

What are the materials chiefly used for making Soap?

The soda is chiefly obtained from the decomposition of sea salt, the lye being frequently made with the unpurified soda in the state of black-ash. The potash is obtained by calcinizing wood-ashes. The principal oily ingredients are tallow or animal fat, and palm-oil, which is obtained from the fruit of the *Elais Guineensis*, or oil palm, a native of the west coast of Africa, where it is extensively cultivated; this trade, which has rapidly increased, is considered one of the most important auxiliaries in the reduction of the slave-trade formerly carried on to so large an extent on this coast.

Olive oil, whale, seal, and cod oil are also used in smaller quantities; a portion of resin is put into yellow soap.

How is Soap made?

The whole quantity of tallow or oil intended to be used is put into the soap-pan (a large iron boiler) at once, but the alkali is supplied at several successive times, the exhausted lyes being pumped out and fresh ones added; a quantity of salt is put into the pan when it is desired to separate the soap from the lye in which it is suspended. Two or three boilings are usually given to it for as many successive days.

When the Soap is properly formed, what is done with it next?

The lye is carefully separated from it, and it is then removed in buckets, to the "frame room," where it is poured into large frames which are like bins, their sides being bolted together. Here the pasty mass is stirred and raked about with a little water to make the grain finer and more equable, and it is then allowed to solidify; when it is quite firm the frame is unbolted and taken off, and a block of soap remains, which is cut up into bars and stowed away to dry. Soft soaps are made in a similar manner, only the exhausted lyes are not pumped off. These soaps always contain half their weight of water; hard soaps may be reckoned to contain one part alkali, nine parts greasy matter, and five or six parts water.

What is Sulphur?

A solid non-metallic mineral known from the remotest antiquity; it is hard, yellow, brittle, and has a disagreeable smell. Sulphur is found native in veins or beds mostly near active volcanoes; it is also found combined with iron, copper, lead, and antimony, forming the most abundant ores of those metals. Native sulphur is found massive, powdery, or cellular, and not unfrequently in large crystals, some of which measure four inches in length. Sulphur abounds in the mineral kingdom, but traces of it are found in both the vegetable and animal kingdoms. The bad smell of some plants, as assafœtida and garlic, is to be attributed to the sulphur they contain; it exists too in eggs and some other animal products; thus it is that eggs discolor silver spoons.

Whence are we supplied with Sulphur?

The native sulphur imported comes mostly from Solfatara in Sicily, but large quantities are procured from iron and copper pyrites. These minerals are heated, and the sulphur being volatile flies off in fumes which are conveyed by pipes to a condensing room. If left in the powdery state in which it condenses it is called flour of sulphur; but, if melted and cast it makes roll sulphur.

What are the uses to which sulphur is applied?

It is used in bleaching, for making gunpowder and matches; it is also used in medicine. One of the combinations of sulphur, *sulphuric acid*, called in commerce, Vitriol, is so largely used in the arts and manufactures, that it has been said the commercial prosperity of a country may be fairly estimated by the amount of sulphuric acid it consumes.

What are salts in medicine?

They apply to the sulphate of magnesia, or Epsom salts, and the sulphate of soda, or Glauber's salts. They are both frequently contained in mineral springs; the first is procured by the action of sulphuric acid on magnesian limestone. It is one of the mildest and best purgatives. The sulphate of soda is commonly called Glauber's salts from the name of its discoverer. It may be made by the direct action of sulphuric acid on the carbonate of soda. Its medical property is cathartic; it acts favorably in all cases of habitual costiveness, bilious colic, etc. Its taste is cooling, saline and bitter.

About Cereals, etc.

How is Bread made?

Bread is made by mixing flour with water and a small portion of yeast; it then rises on being placed in a warm situation, and is kneaded, made into loaves, and baked.

Why does the Dough rise?

To understand this, it will be needful to explain the constituents of wheaten flour, which, like most kinds of vegetable food, consists of two essential ingredients. These may easily be separated from each other by tying up a bit of dough in a linen bag, and kneading it in cold water. A white powdery substance exudes, which sinks to the bottom of the vessel when the water is at rest, the bag contains a dirty white gluey substance which is called *gluten*, and the white powder separated by washing is the *starch*; there is also a large portion of water in the grain. Gluten is the most nourishing of these substances; and, as the largest proportion of this is contained in the bran or outer skin, meal in which this is ground up with the flour, is much more nourishing than white flour. Now when the flour and water are mixed with yeast and set by the fire, the heat and the action of the yeast turn part of the starch contained in the flour into sugar; and this fermenting, small bubbles of carbonic-acid gas, the same gas which causes the effervescence of soda-water, champagne, etc., are thrown off; but the sticky nature of the gluten prevents their escaping, they are, therefore, held in, and the whole mass becomes porous and light. When set in the oven, the bread continues to rise till the whole mass is heated to about the temperature of boiling water, when the fermentation is suddenly checked;

and the after-baking sets the loaf in the form to which it had risen, and renders it fit to eat.

What is Yeast?

The frothy substance that rises to the surface during the fermenting of malt liquors; it contains the fermenting principle, which is the cause of the rising of the dough by the disengagement of the carbonic-acid gas.

How is Wheat made into flour?

The whole grain, after threshing, is ground at the mill; this produces meal, which, as before stated, is more nourishing than fine flour; it is then sifted through canvas, which is made of various degrees of fineness, suited to the quality of flour required; the rough and hard exterior covering of the grain being thus kept back, and only the flour passing through—which is then fit to make bread.

Are any other grains beside Wheat made into flour?

Yes, Rye and Barley are, and many others. The plants which bear these grains are all grasses; annuals, with a hollow straw or stalk full of joints or knots, and they die both in stem and root when the seed is ripened. The seeds of all these grasses are fit for food, except the darnel, *Lolium temulentum*, which is poisonous; but many are not employed on account of their small size. The principal kinds cultivated are wheat, barley, rye, oats, maize, rice, and millet. They are called cereals from Ceres, who was the fabled goddess of corn and agriculture, and who is generally represented as being crowned with ears of wheat.

Where do these plants grow?

It is a remarkable and providential fact, that from their diversity of habits, some one of them is found capable of culture in almost every country suited to the habitation of man; and in those few places where they do not thrive, some other plant capable of affording the vegetable diet so needful for man is found in their stead. Barley and oats are the grain most cultivated in northern climates, they like light, loamy soils; then comes rye, which prefers sandy situations; and as we go farther south wheat becomes the staple produce; this grain prefers the stiff, clayey soils. Rice, maize, and millet are essentially the cereals of hot climates; the former especially growing on the low wet land in the tropics, which would be useful for the cultivation of no other grain; wherever the land on which it grows is not naturally flooded, *irrigation* is needful: millet, on the contrary, thrives best in arid soils, and hence fills a similar position among the corn plants of hot climates to that of barley and rye among those of colder regions; and millet and rice together supply the greater part of the East with food. Maize came originally from America, though it is now cultivated in many parts both of Asia and Africa, as well as in southern Europe.

Which is the most valuable of these?

Wheat is generally considered so, and preferred in those countries whose soil and climate admit of its cultivation. The origin of this valuable grain is enveloped in considerable mystery; some persons believing that it has never been found in a wild state; and others, that the wild and useless grass which grows on the borders of the Mediterranean, and is known as the Ægilops, could, by years of cultivation and care, be converted into real, true wheat; whichever supposition is true, the fact cannot be doubted, that the continued supply of this most useful food has been made dependent on man's continued industry.

Are there many kinds of Wheat?

Yes; there are many varieties of wheat (*Triticum*) in cultivation; but in all the culm or stalk bears a simple head or ear, containing the seeds, each enclosed in a husk; some varieties have spikes or awns attached to the husk and are called bearded. Wheat is exceedingly prolific, so that a few grains carefully cultivated would, in a few seasons, produce a sufficient supply for a large number of men. Egyptian wheat, which has been raised from a few seeds found wrapped up with a mummy, produced stalks of which each one bore five or seven heads, like the wheat described in Pharaoh's dream.

This is a curious proof, too, of the long time seeds retain their vitality. Here were these grains of corn kept dry in the catacombs from the days of the Pharaohs, perhaps from the time when the children of Israel worked as bond-slaves for their cruel taskmasters; and yet, when they were brought into favorable circumstances, they sprung up as fresh and as beautiful as though they had ripened last year in our own cornfields.

Is Barley as nourishing as Wheat?

Yes; barley, *Hordeum*, and rye, *Secale*, resemble wheat very much in their qualities; though the former contains a portion of sugar ready formed, which renders it sweeter and more fitted for making into malt than any other grain. Barley, not requiring much moisture, and coming rapidly to perfection, is suited to the short summers of the northern regions, where it thrives; it is a bearded grain, with a single spike, and does not grow so tall as wheat. Rye is very similar to wheat in its growth, but the ear is smaller and darker; it is much used in the countries bordering on the Baltic Sea, and other places where it is abundant, both for brewing and for making bread; rye-bread is coarser and sweeter than wheaten bread, and not by any means so white, but it possesses the valuable quality of not readily becoming dry and stale.

How is Malt made?

A quantity of barley which has previously been well moistened, is strewed on a brick floor, the room being kept dark; the barley grains begin to sprout, and in this process the moisture is all absorbed, the grains swell, and part of the starch they contain is changed into sugar: at the time when there is the most sugar held in the seed, and the young plant has not begun to change and absorb it, a fire is lighted under the floor, and it is all dried, and the young plants thus killed. The malt is then fit for use in brewing.

For what are Oats remarkable?

The *Avena*, or Oat, is remarkable for its great hardiness, growing in colder and less fertile regions than any other grain, and yet containing a larger portion of the nutritious gluten than any other of the class. This is the reason why the Scotch people, who live principally on oatmeal, either in the form of porridge or oat-cakes, find it so valuable a source of food.

In England oats are chiefly used for feeding horses. Oats do not grow in a single spike, but in a branching spray, each grain on a separate little stalk. When these are young and light, this loose spike stands erect, but as they increase in weight the stem is generally bent down gracefully on one side: this kind of spike is called a *panicle.*

What is Rice like?

Rice (*Oryza*) is a panicled grass something like oats. Each grain is awned, that is, has a pointed beard, and is covered with a golden yellow husk. The proportion of gluten contained in rice is small, and there is no ready-formed sugar in it like barley; hence it is not by any means a nutritious diet, though it is light and wholesome. It is grown extensively in portions of the Southern states and forms an important part of the exports.

What kind of a plant is Maize?

The maize, or Indian corn (*Zea mays*), is the largest of the cereals we are acquainted with, often rising to the height of six or eight feet; it has a strong, jointed stalk, sheathed in large handsome flag-like leaves, which bears a large head of hard glossy seeds, growing on a central stem called a *cobb;* and the whole head is enveloped in one sheath instead of each grain being separately enclosed. Maize contains an average portion of gluten, and a larger portion of vegetable *fat* than any other grain; which renders it a very valuable and fattening kind of food. It does not, however, make such good bread as wheaten flour, and is chiefly employed to make cakes which are to be eaten hot.

What sort of a grain is Millet?

Millet, *Sorghum vulgare*, called Dhurra in the East, is the smallest of all the cereals raised for food; its soft downy spike or ear containing a large number of very small seeds. It is the chief article of food to the inhabitants of central India, Arabia, and many parts of Africa; it is very nutritious; containing a large proportion of gluten.

Is not flour obtained from the seeds of any other class of plants than the grasses?

Yes; there is a kind of flour made from the seeds of the buckwheat, *Polygonum fagopyrum*, a small plant with upright stems, heart-shaped leaves, and small pale-pink flowers.

Are the seeds of no other plant ground into flour for food?

Yes; the Quinoa, *Chenopodium quinoa*, which is very largely cultivated on the high table-lands of Chili and Peru, flourishing at an altitude where neither barley nor rye would ripen. It yields a very nutritious food, the flour resembling oatmeal in many of its qualities. The plant rises to the height of about six feet; has large deeply-cut leaves; and complex spikes of flowers, which produce small roundish seeds.

Are there not other vegetable substances used for food in some cases instead of grain?

There are the potato, the turnip, the carrot, the yam, the sweet potato, and a countless host of other roots and tubers, which yield, in various proportions, the same nutritious elements as corn; though none of them contain so much nourishment as wheat-meal and oat-meal.

But the natives of warm climates eat fruits to supply the place of bread, do they not?

Yes; the Bread-Fruit, *Artocarpus incisa*, which is a native of the islands of the Pacific; it is a large and handsome forest tree, bearing abundantly a large round fruit, often as large as a child's head. The fruit ripens at different times of the year, so that for eight months out of the twelve there is a supply. It is generally baked before it is eaten, and for this purpose it is preferred before it is perfectly ripe, while the rind is still green, but the interior pith snow white; when thus prepared its taste is like wheaten-bread, but rather sweeter. The Chilian Pine, *Araucaria imbricata*, which is a recently introduced ornament of our parks and shrubberies, on the slopes of the Andes of Chili and Patagonia attains a lofty height and extends in natural forests. The trees bear cones six inches in diameter, the seeds of which are large, and supply farinaceous food to a large population.

Can you tell me of other trees which are valuable for the same reason?

The Plantain and the Banana, *Musa paradisiaca* and *Musa sapientum*, to which I have alluded under Fruits; they are graceful and striking tropical trees, related to the palms; their straight branchless stems bear a crown of large broad leaves; and also a long pendant spike of flowers, succeeded by finger-like fruit; which, when partially ripe, are mealy, and are often cooked for bread; and which, when quite ripe, are very delicious. There are many other of these trees supplying large portions of the globe with food, some of which have been described among Fruits; all of them supply *gluten* and *starch*, except that where the *ripe* fruit is used, some of the starch has been converted by the process of ripening into sugar.

Do any other vegetable substances yield starch beside seeds, fruits, and roots?

Yes; it is found in the stems of many plants, especially of the palm tribe; and in several of the lichens; in fact, it is, probably, with the exception of woody fibre, the most universally diffused of all vegetable principles. In whatever part of the plant starch is contained, it is found floating in aqueous fluid in little cells.

Are there different kinds of starch?

Chemically speaking, there is only one kind; but several varieties are found in commerce, differing slightly according to the plants in which they are found, and the means by which they are obtained. These may be divided into two classes—starch, commonly so called, used in the arts, and various modifications of it employed for food; the first kind is mostly produced from wheat, barley, rice, and potatoes; the second is known as arrowroot, sago, tapioca, tous-les-mois, etc.

How is Starch made?

The chief operation consists in removing the gluten; this has been effected in various ways; one consists in mixing the flour with water, and allowing it slightly to ferment, when the acid formed dissolves the gluten; but by this means a portion of the starch is lost, and the work is rendered unwholesome by the noxious vapors which rise; another plan is merely a carrying out of the simplest means for separating the two ingredients—namely, washing in cold water; by this means a large portion of the gluten is preserved as well as the starch; a different plan has been devised, in which the gluten is dissolved in diluted acid, the starch remaining unaltered. When the starch is sufficiently pure, it is blued with smalt, and then gradually dried; during which process it splits with much regularity into the prismatic columns in which wheaten starch is commonly met with.

From what is Arrowroot prepared?

From the root of the *Maranta arundinacea* and *Indica*; the former species is a native of South America and Jamaica; its mashed root is applied by the native Indians to wounds from poisoned arrows—hence its English name. To prepare arrowroot, the tubers of a year old are well washed, and beaten to a thin pulp; this is again washed, and the woody fibre wrung out by the hands and thrown away; the milky liquor is then strained, the starch allowed to settle, and afterward washed and dried.

What is Sago?

A kind of starch derived from the pith of the sago palm, *Sagus farinifera*, which grows in Africa and the East Indies. When the tree is sufficiently mature, it is cut down, and the trunk is cut into portions of six or seven feet in length, which are split lengthwise; the pith is taken out, mixed with water, and pounded; the mixture is strained, and the starch settles; it must be washed several times. The sago-meal, as it is called, is then made into a paste, and rubbed into small grains. The sago palm yields the largest quantity of pith just before the expansion of the flower-bud; one tree often affords five or six hundred pounds of sago.

What are Cassava and Tapioca?

Cassava is a farinaceous substance imported into this country from South America, the West Indies, and some parts of the coast of Africa, and called the Brazilian arrowroot. It is obtained from the root of the Manioc, or *Jatropha manihot*, a native of Brazil. The roots are peeled, reduced to a pulp, and squeezed to separate their poisonous juice, which contains a considerable portion of prussic acid; the mass is dried to evaporate the remainder of the juice, and reduced to powder, in which state it is used to make cassava bread, an important article of food to the negroes. Tapioca is the starch of this root separated from its other particles, and dried on hot plates, with agitation; which causes it to adhere together in little granular masses.

What is Tous-les-mois?

The powder known by this name has recently been imported from the West Indies; and it is said to be prepared from the root of the *Canna coccinea.* Potato starch is used as a cheap substitute for all these forms of farina and is often employed to adulterate them.

What is Macaroni?

A preparation of fine flour which forms a favorite article among the Italians. It is eaten in various ways; usually simply boiled, and served up with grated cheese. It is prepared as follows: a superior quality of wheat is selected and made into a paste, in which so little water is used that it becomes too hard to knead with the hand, a wooden pole, or lever, being used for the purpose. When sufficiently worked, the paste is put into a hollow, cylindrical vessel, having its bottom pierced with holes about the size of a goose-quill. A piece of wood which exactly fits the inside of the cylinder is forced down upon the paste by a screw, which, by this means, is forced through the holes in the form of the hollow tubes in which we see it. The macaroni is partly baked as it issues from these holes, by a fire that is placed below the cylinder; and as it descends, it is drawn away, and hung on rods to dry.

What is Vermicelli?

A preparation similar to macaroni, but to the paste, yolks of eggs, sugar, and saffron are added.

What is Salop?

A nutritious article of diet imported from the East Indies, Turkey, Syria, and Persia. It consists almost entirely of a peculiar vegetable principle called *bassorin.* Its nutritive qualities are so superior, that it is said that an ounce a day is sufficient to sustain a man. It is prepared from the roots of different species of *Orchideæ.* The tubers are deprived of their cuticle by being dipped in warm water, and then submitted to the friction of a coarse cloth. They are then heated in an oven for a period of ten minutes, during which time they will exchange their milky whiteness to a yellow, semitransparent, and horny appearance.

About Cheese, Butter, etc.

How is Cheese made?

Milk is warmed and curdled with rennet, which is a substance procured from the stomach of a sucking calf, and is the natural juice intended to separate the curd from the whey, for the nourishment of the young animal. All milk consists of three distinct substances; the oil or *butter*, the solid part, or *curd*, and the *whey*, which is a thin transparent fluid. After the curd has been well formed in the milk, it is much stirred and broken with the hand; and is then collected on a coarse cloth, and put into a shape, formed by a wooden hoop held together by a string passed round, so that it can easily be opened and removed. When the cheese has begun to harden, a circular board is placed on the top of it, and it is subjected to heavy pressure. After being repeatedly turned in the press, and having salt rubbed on it to prevent fermentation, it is set on a shelf to dry, and when dried is ready for sale.

Are there not many different kinds and qualities of Cheese?

Yes; varying in richness from cream-cheese, which is or should be made entirely of cream, to the far-famed Suffolk cheese of England, said to be made of milk—

> "Three times skimm'd, sky blue!"

> ———— "Ye Cheshire meads,
> Or Severn's flowery dales, where plenty treads,
> Was your rich milk to suffer wrongs like these,
> Farewell your pride! farewell renowned cheese."
>
> *Bloomfield's Farmer's Boy.*

But Cream-Cheese could not bear the pressure you have described?

No; cream-cheese is usually placed on a kind of mat, made of straws strung together, and turned every day. It will not keep.

What Cheese does the poet refer to as the produce of "Severn's flowery dales?"

Gloucester and Cheddar cheese; the latter, which is made in the rich valleys near the Cheddar rocks, the most romantic part of Somersetshire, is highly prized.

Which is the most celebrated of the English Cheeses?

The celebrated Stilton cheese, which is made in Leicestershire, although it obtained its name from a small town in Huntingdonshire, on the great north road, where it was first publicly sold by retail. This cheese is sometimes called the Parmesan of England; the process of making it was for some time kept a secret, but is now generally known. The cream of the preceding evening's milking is added to the morning's new milk, with a proper quantity of rennet. The curd is not broken in the usual way, but taken out carefully, and placed in a sieve to drain gradually, when it is gently pressed till it becomes firm and dry. It requires much care to keep it sweet and good till fit for use. When fully ripe a portion of green mould appears in it.

What occasions the difference in the color of some Cheese?

Many kinds of cheese are artificially colored, which no doubt was originally done in order to make the cheese look richer. Arnatto, or *Annotta*, which is a red dye, procured from the pulp of the seed-vessels of a tree called Bixa, and brought from the West Indies, is the substance most frequently used; but the juice of the orange, and carrot, and of marigold flowers, is also employed.

What is Parmesan Cheese, to which you compare Stilton?

This celebrated cheese, which comes from Parma in the north of Italy, is made from milk which has been skimmed; and there does not appear any reason to be assigned for its excellence except the richness of the herbage on the banks of the river Po, on which the cows are fed. The only difference in its mode of preparation from that of other cheese is that the coagulation is effected in a cauldron hung over a fire, and the milk is therefore probably hotter than in ordinary cases. Parmesan cheese should be kept a long while, at least three years, and none is considered fit for sale before it has been made half a year. A large portion of the profit of farming in Parma is derived from these cheeses and from the good butter.

What are those round Cheeses we see in the shops?

They are Dutch Cheeses; they are made of skimmed milk, and the curd is well washed and saturated in salt and water before it is pressed into the mould; which operation, while it rather spoils the flavor of these cheeses gives them the valuable quality of keeping well in all climates. In Germany a small cheese is made by turning the milk sour by the heat of the fire; the whey is then pressed out, and the curd is broken fine with the hand in a tub; in this state it remains till the putrid fermentation begins, when it is made into little balls and dried. Sometimes caraway seeds are added, and these little cheeses are often smoked in the chimney. They are not bad in flavor, but have a most unpleasant smell. In Switzerland a small green cheese is made, in which the curd is mixed by the dried leaves of the melilot reduced to powder. When to be eaten it is grated, and the powder mixed with fresh butter is spread on bread. The Swiss also make a common cheese from the curd left in the whey after better cheese has been made; it has very little flavor, but serves the people on the mountains for bread; they cut slices of it, spread butter over and a thin slice of cheese over that, and wash it all down with a cup of fresh or fermented whey, or, if they can afford it, a glass of Kirschwasser, which is a spirit distilled from cherries, or gentian brandy.

Is Cheese ever made from the milk of any other animal than the cow?

Yes; the rich little cheeses sold as Neufchatel cheeses are said to be made from goats' milk; which is much thicker, and yields more cream than cow's milk; it is much used by the natives of mountainous countries, as the goat can climb and find abundant food where the cow could neither find foot-hold nor pasture. In Lapland, the milk of the reindeer is used, the herds of these beautiful and useful creatures being brought home every night to be milked; which produces a very animated scene at the *gamme*, or encampment; the dogs barking, the reindeer bounding along, standing still occasionally, then starting again, tossing their large antlers till they come near the tents, where the Lapland lasses are waiting to milk them; each deer has to be held during this time by a cord slipped round its horns, as they are very restless.

What animals give milk to the people of hot climates?

Different races of cows are found in India and South Africa; and some of the Arabs and other Nomadic tribes of the east are supplied by the milk of their camels, which they convert into cheese and butter; the latter is often made by putting the cream into a skin sack prepared, and then two women shake it to and fro until the butter is formed. The Arabs sometimes use the milk of their mares, and asses' milk, which latter is considered very nourishing, and often prescribed in England for invalids.

What is Butter?

The fat or oleaginous parts of milk, separated from the thinner parts by agitation in a machine called a churn. The milk is first placed in shallow vessels, upon the surface of which, after standing twelve or twenty-four hours, the cream or caseous matter rises. This is placed in the churn, a hollow cylindrical vessel, in which a piston or plunger works with a perpendicular motion; when the milk has been agitated and sufficiently shaken, a solid called *butter*, and a liquid called *butter-milk*, are the products. The cakes of butter are then taken out, washed, salted, and worked up into an even mass. Too much attention cannot be paid to the most minute circumstances in the manufacture of butter, especially in all that relates to cleanliness. It is well known that even the complexion and temperament of a dairy-woman are not matters of indifference; and that, however clean she may be, there are times when the insensible perspiration of her body will have a powerful effect on the milk. Even mere effluvia may give a turn to the chemical action which commences as soon as the milk is exposed to the air. In Switzerland men are chiefly employed in milking and in making butter and cheese, the women only cleaning the utensils, and carrying green food to the cows when kept in the stable.

What proportion of Butter is obtained from milk?

Upon an average, four gallons of milk produce sixteen ounces of butter. The best butter is produced from cows fed in rich natural meadows. The best winter butter is made where the cows are fed with good meadow hay, such as contains few seed-stalks.

What is whey-butter?

An inferior kind made in some cheese-dairies from the oily portion of the milk skimmed from the whey. It is quite unfit for salting or keeping.

In warm countries the place of butter is for the most part supplied by oil - as in Italy, Spain, and Portugal. In India they make use of *Ghee*, which means butter clarified by boiling. The origin of the use of butter is uncertain. Beckman (History of Inventions) comes to the conclusion that butter is not of Grecian or Roman invention, but that the Greeks received it from the Scythians, Thracians, and Phrygians, and that the Romans derived it from the people of Germany, and used it as a medicine rather than as a culinary luxury. The word *chameah*, translated butter in the English version of the Bible, means some liquid preparation of milk or cream.

About Narcotics.

What is the meaning of Narcotic?

It is a word of Greek derivation, and means to render torpid. Narcotics are classes of medicines which cause a temperate increase of the action of the nervous system, followed more or less speedily by a marked diminution of this action, terminating generally in sleep. When the dose is large, there is a tendency to convulsions and apoplexy, which sometimes result in death. The power of narcotics in producing sleep has procured for them the name of soporifics; while the property they possess for alleviating pain has also obtained for them the appellation of anodynes or opiates.

What are the principal narcotics?

Tobacco, opium, betel-nuts, hemp, the coca-leaf, the poppy, and the thorn-apple.

What is Tobacco?

The leaf of various species of *Nicotiana*—a plant which is a native of tropical America, but which grows readily in many climates. It has been introduced into almost every part of the globe; and it is thought by many to have been indigenous in China and Central Asia, as well as in the New World.

When was it first used for Smoking?

Columbus found the Indian chiefs in the habit of smoking cigars when he first discovered the West India Isles; tobacco was brought to France in 1560; and to England in 1586, by Sir Francis Drake and Sir Walter Raleigh. At first the use of it was very much discouraged, and James the First published a "Counterblast to Tobacco;" but opposition only increased the desire to try the novelty, and caused it to spread more rapidly. It is related of Sir Walter Raleigh, that when he returned to England and indulged himself in smoking, which he had learned to like while in America—his servant came in one day, and seeing smoke issuing from his master's mouth thought he was on fire, ran to give the alarm, and to seek water with which to extinguish the flames, which he momentarily expected to see follow the smoke. The fashionable pipes in his days were of silver, while those who could not afford so expensive an article used a walnut-shell with a reed inserted. Long after smoking became a common practice it was held to be improper for a clergyman; and in the days of our great-grandfathers it really was a very costly habit, as tobacco was then sold for its weight in silver.

How is tobacco prepared for use?

The leaves are gathered, dried, and either pounded, or cut up into shreds, or twisted into a thick string, according to the kind of tobacco they are intended to make. Cigars are made of dried leaves without the midrib, rolled up into a short spindle; they are sometimes sprinkled with saltpetre to make them burn better.

How is Snuff made?

The dried leaves of the tobacco plant are sprinkled with water, piled up, and left to ferment for several months; they are then reduced to powder, wetted with salt water, and again allowed to ferment; this gives them an agreeable odor, and the well-known pungency of snuff. Some snuffs are made of the fleshy part of the leaves, others of the midribs.

Why do people smoke tobacco? what effect does it produce?

It is a soothing narcotic, producing poisonous effects when indulged in to excess, but otherwise only a dreamy unconsciousness to care and trouble. "In habitual smokers," says Dr. Pereira, "the practice, when moderately indulged, provokes thirst, increases the secretion of saliva, and produces that remarkably soothing and tranquilizing effect on the mind, which has caused it to be so much admired and adopted by all classes of society." Indeed all nations, whether barbarous or civilized, appear to possess the craving for narcotics; and the plants which have been found to yield them are singularly various. It has been estimated that the average consumption of tobacco by the whole human race is seventy ounces a head—a yearly aggregate of two millions of tons. Professor Johnston declares that the tobacco yearly raised for the gratification of this one form of the narcotic appetite, weighs as much as the wheat consumed by ten millions of people.

Is the use of Tobacco deleterious?

With some constitutions it never agrees; but Dr. Pereira and others no less eminent have declared, "that no well ascertained ill-effects have been shown to result from the habitual effects of smoking." It is to be presumed that its use in moderation is meant; and we must not withhold the fact that other physicians are of a different opinion.

Are there any other narcotics much in use?

Yes, opium, hemp, and the betel-nut, among the Eastern Asiatics; the coca-leaf and thorn-apple in South America; and the amantia, or narcotic fungus, in Siberia; besides these, the common hop possesses narcotic properties.

What is Opium?

The juice of the seed-vessels of the white poppy, *Papaver somniferum*, obtained by making incisions in the seed-vessel before it is quite ripe, when the juice exudes, and is daily collected. The practice of eating and smoking opium is very frequent in the east, the narcotic intoxication it produces being of the most exquisite kind; but the after-effects of excess are proportionably horrible, destroying all power and energy both of body and mind. It is consumed in the form of pills, smoked in small pipes, and used in fluid tinctures.

Where is Opium grown?

Principally in India, where at least 300,000 acres are devoted to its culture. The Chinese are the largest consumers, importing not less than four to five millions of pounds' weight annually, at a market value of as many pounds sterling.

Is not Laudanum made from opium?

Yes, laudanum and morphia, both of which are used as stillers of pain and sleep-producers, are only other forms of opium. Many cordials, too, are prepared from it which are given to infants to quiet them, but produce the most baneful effects, often ending in death.

What kind of a plant is the Hemp which is used as a narcotic?

The same plant, *Cannabis sativa*, or *Indica*, which produces the hemp fibre, yields in hot climates a resinous extract, which is violently exhilarating and exciting in its effects; so much so, that the word *assassin* is said to be derived from the furious conduct of the Haschiseens, as those who use the haschisch, or hemp resin, are called.

How is Haschisch prepared?

By boiling the leaves and flowers of the hemp in water, to which butter is added, and the decoction, when reduced to the thickness of a syrup, is strained through a cloth. The taste is very disagreeable, and is qualified with camphor, cloves, or other spice.

What is the effect of Haschisch?

That of an intense feeling of happiness; an exhilaration amounting to ecstasy. Visions of the most gorgeous character flit through the imagination of the partaker; "the sun shines upon every thought that passes through the brain, and every movement of the body is a source of enjoyment."

Where does the Betel-Nut grow?

On all the higher ground in India, the valleys of the Himalayas, in Ceylon, the Sunda Isles, and the Philippines. This nut, which is about the size of a cherry, slightly pear-shaped, and very hard, not much unlike a bad nutmeg, is the seed of one of the most graceful of the palm tribe, the *Areca catechu.*

How do these people use it; is it smoked?

Oh no, it is chewed; the buyos, or betel rolls, are made by the females of the household. The nut is cut into strips and rolled up in a leaf of the betel pepper, *Chavica betle*, which is dusted on the inner side with quick-lime made from burnt shells. These buyos, or the materials for making them, are the chief luxury and delight of the natives, who take them about with them in little caskets; and if they can afford it are seldom without one in their mouths. It is the employment of the women and girls to make these buyos, and they may be seen in groups reclining in the shade, and filling the little caskets belonging to their fathers, husbands, or brothers; these caskets are often of the most exquisite workmanship, being more highly valued than any other similar possession. The quantity of betel consumed is enormous, as may readily be believed when it is known that the betel-nut is chewed by not less than fifty millions of men.

What is the name of the tree that yields the Coca-Leaf?

The *Erythroxylon coca*; it grows wild in the tropical valleys of the Andes, in Bolivia, and Peru; but the coca which is used is chiefly the produce of cultivated plants. The shrub resembles a blackthorn, with its small white flowers and bright green leaves. The leaves are gathered when quite mature, and dried in the sun, during which operation they smell like newly mown hay. The dried leaves are chewed with quick-lime, or the ashes of some kinds of roots, in the same manner as the betel, and to the dwellers on the Andes they form as much an article of necessity as of luxury. Furnished with his coca-pouch, the South American Indian can perform the most fatiguing journeys and the most laborious tasks, with but little rest and food.

What are the effects of the Thorn-apple when used as a narcotic?

The thorn-apple, or *Datura*, of which two species are used—the *Sanguinea* and the *Stramonium*—seems to possess the most remarkable narcotic property in every part. The intoxication produced by its use gives rise to spectral illusions of the most wild and extravagant kind; which has occasioned the belief among the Indians of South America that, under its influence, they are permitted to hold communion with the spirits of their ancestors. In Europe the *Datura stramonium* is often smoked as a remedy for the asthma.

About Textile Fabrics.

What is a Print Dress made of?

It is made of calico or muslin, printed with a pattern to make it pretty. Calico and muslin are woven fabrics made of cotton; and all kinds of cloth formed or spun of woven threads fall under the title of textile fabrics.

What is Cotton?

A downy substance produced on the seeds of the cotton plant, *Gossypium*, which is herbaceous, and of a height varying from four to twenty feet, according to the species; it has downy lobed leaves, and flowers similar in form to those of the common mallow, to which it is related; in some species the flower is yellow, and in others of a dull purple color. The seed-vessel is a capsule, which opens into from three to five lobes, and shows the seeds, which are quite covered with cotton; in some cases this is of a bright buff color, and sometimes it is white. Plants are often covered with hairs in different parts, some having downy stalks, and some downy leaves like the mullein; but it is remarkable that hairs on the seeds are not at all common, being in fact very much confined to those plants which are allied to the cotton-plant.

Why do we consider Cotton not so strong as Linen?

Because linen, which is made of the stalks of the flax, *Linum*, is a preparation of woody fibre, which is the strongest and most enduring of vegetable substances, whilst cotton is only composed of the cellular tissue; hairs of cotton are in fact indefinitely minute tubes, thin and transparent, and possessing so little strength that it is not until a great number of them are twisted together that their resistance can be felt; while on the contrary, a single fibre of flax presents an appreciable degree of strength.

Where does the Cotton-Plant grow wild?

It seems to have been indigenous in both the old world and the new; it has been known in India from time immemorial, and still grows wild in many parts. Herodotus mentions, in describing the wonders of India, that this people "possess a kind of plant, which, instead of fruit, produces *wool* of a finer and better quality than that of the sheep; of this the Indians make their clothes." The Greek historian implies that this plant was peculiar to India. When the Spaniards first landed in America, they found it growing wild there; the species native to the different continents are very dissimilar; but both are grown in the present day in India as well as in America. Dr. Livingstone, the great modern discoverer, in describing the new land he has brought to light in central Africa, says that both cotton and indigo grow wild over the face of the country, which appears eminently fitted for their cultivation.

Where was Cotton first made into Cloth?

Probably in India, where, as we have said, the plant has been known and cultivated from time immemorial. The Hindoos exhibit a most wonderful proficiency in spinning and weaving their cotton, with the simplest and rudest implements, into many varieties of fabrics, including fine muslins; indeed, till toward the close of the last century, the finest muslins in use were imported from India. The earliest mention of cotton among the classic nations of antiquity is by Herodotus, who speaks of it by the very descriptive name of *tree-wool*, which is the name it still bears in German and several other continental languages. Cotton was not known in Egypt until about five hundred years before Christ, and then it appears more probable that it was imported than that it grew there; for all the cloths found enveloping the mummies of earlier ages have proved on examination to be linen; and, though the pictured records of this people often represent the flax plant, there is no trace of cotton.

Are there no Mummies anywhere else in the world?

Yes, in Mexico and Peru the original inhabitants possessed the art of embalming the bodies of their relations, and these are always found enclosed in cotton cloths, which must have been made long before those countries were discovered by Europeans. The Mexicans made mixed fabrics of cotton and the finest hair of rabbits or similar animals; and they wove their cloths of different figures and colors, representing different animals and flowers. These ingenious people introduced feathers also into their manufactures, and made in this manner mantles and bed-curtains, carpets and other things, which were exquisitely soft and beautiful.

Among the presents sent by Cortes to Charles V. are enumerated "cotton mantles, some all white, others mixed with white and black or red, green, yellow, and blue; waistcoats, handkerchiefs, counterpanes, tapestries, and carpets of cotton, and the colors of the cottons were extremely fine." This latter statement will be readily believed when it is known that the Mexicans had both indigo and cochineal among their native dies.

Was Cotton early known in China?

No; it seems remarkable, and is a proof of the stationary state of Chinese civilization, that an article of such unrivalled cheapness and utility should have been known for so many ages to their Indian neighbors without having been introduced into the "celestial empire." Some old Arabian travellers recount that in the ninth century every one in China, from the prince to the beggar, was clothed in *silk*. After the Tartars conquered the country, cotton began to be cultivated for common use, and, though strongly opposed by all those interested in the silk manufacture, it finally triumphed over every obstacle, and now cottons, dyed of a blue color, are universally worn by the poorer classes of both sexes. One kind of Chinese cotton manufacture attained even world-wide celebrity; the nankeens, which take their name from the city of Nankin, were a fine stout cloth made from a variety of the cotton plant which yields a yellow down, the native color of which proved lasting. In Japan, in Java, and the countless islands in the Indian seas, cotton is the usual clothing of the people.

How was Cotton first introduced into Europe?

The productions of the rude looms of India were brought by Greek and Arabian traders to ports of the Mediterranean, and thus found their way to the markets of Europe; where their rarity as well as their beauty made them much sought after;—they consisted of delicate muslins, flowered cottons and chintzes, and were mostly painted with brilliant colors by hand-labor. Cotton cloths are mentioned as having been imported into London, from the Bight of Benin, in the year 1590, the knowledge of both the culture and manufacture having probably been conveyed there by the Moors and other Mohammedan nations; the former were the means of first bringing this manufacture into Europe. In the tenth century the cotton-plant, the sugar-cane, rice, and the silk-worm, were all introduced into the fertile plains of Valencia, where the first still grows wild, though the flourishing manufactures carried on in that century, at Cordova, Granada and Seville, have long since ceased to exist. These southern cities appeared to have rivalled the eastern seats of Mohammedan splendor, Bagdad and Damascus; and while the rest of Europe was as yet unawakened from the lethargy of the dark ages, science, letters, and every kind of industry flourished in Spain under the Moors. In the thirteenth century the native Spanish manufacturers of cotton formed one of the incorporated companies of Barcelona, in which place there are two streets which bear names which point them out as the quarter where this art was carried on. A good proportion of the cloth woven was used for sail-cloth, and all the rest was of coarse quality. The name *fustian*, now applied to a stout, ribbed cotton material, was derived from the Spanish word *fuste*, signifying *substance*, and applied by the weavers of that country to their works. The Saracens, who then had possession of the island of Sicily, paid some attention to the growth of cotton, and had it not been for the mutual repugnance of the Christians and the Mohammedans, there seems no reason why the knowledge of this most useful article should not have been spread among Europeans much sooner than it was.

When was the Cotton Manufacture first attempted?

The knowledge of the art was introduced into England from the Netherlands by some of the Protestant refugees. An old book, called the "Treasure of Traffic," makes the earliest mention of the manufacture in England. The author says: "The town of Manchester buys cotton-wool in London that comes from Cyprus and Smyrna, and works the same into fustians, vermillions, and dimities." For a long time the trade was carried on upon a very different system from that now adopted: the weavers who lived in the villages in the manufacturing districts purchased the material, and their wives having spun and they woven it, they carried it to market and sold it on their own account to dealers. About the year 1760, the merchants began to employ the weavers, giving them yarn for warp, and cotton to be spun into weft, and paying them for their labor.

How was the raw Cotton spun by hand?

It first passed through the preliminary process of carding to straighten its fibres, and make them all lie in one direction instead of crossing one another at every possible angle. These cards are a kind of brush made of short wires passing through a piece of leather; and at first they were fastened to a piece of wood, and used one in each hand; then one large card was fixed and smaller ones used on it, which was immediately followed by the invention of revolving cylinder cards. The first spinning apparatus was the distaff and spindle, which were probably as old as the days of Abraham, and which, in some form or other, are to be met with in all nations at all removed from barbarism. The distaff was wound with the raw cotton, the other end of which was made fast to the spindle which hung down and twirled round and so twisted the thread, the quality and evenness being regulated by the fingers of the spinner. About the reign of Henry VIII. the spinning-wheel came into use in England; in this a large broad wheel, turned by the right hand, supplied the place of the spindle, and wound the thread into convenient hanks as well as spun it.

How is the Cotton spun now?

It would be rather difficult to make you understand the process unless you saw the machines. The following description, written by a person fully acquainted with the whole subject, will explain it better than I could do: "In every mode of spinning the ends to be accomplished are, to draw out the loose fibres of the cotton-wool in a regular and continuous line, and after reducing the fleecy roll to the requisite tenuity, to twist it into a thread. Previous to the operation of spinning, the cotton must have undergone the process of carding, the effect of which is to comb out, straighten, and lay parallel to each other its entangled fibres. The cotton was formerly stripped off the cards in loose rolls, called cardings or slivers, and the only difference between the slivers produced by the old hand-cards and those produced by the present carding engine is, that the former were in lengths of a few inches, and the latter are of a length of some hundreds of yards. Let it be remarked that the sliver or carding requires to be drawn out to a considerably greater fineness before it is of the proper thickness to be twisted into a thread. The way in which this is now accomplished is by two or more pairs of small rollers placed horizontally, the upper and lower roller of each pair revolving in contact; the sliver of cotton being put between the first pair of rollers is by their revolution drawn through and compressed; whilst still passing through these rollers, it is caught by another pair of rollers placed immediately in front, which revolve with three, four, or five times the velocity of the first pair, and therefore draw out the sliver to three, four, or five times its former length and degree of fineness. After passing through the last pair of rollers, the reduced sliver is attached to a spindle and fly-wheel, the rapid revolutions of which twist it into a thread, and at the same time wind it upon a bobbin. It is manifest that, by increasing the length of roller and the number of slivers, a hundred or a thousand threads could be drawn out and spun as easily as one."* This is the invention generally ascribed to Sir Richard Arkwright, but which others attribute to a John Wyatt, whose partner, a man named Lewis Paul, took out a patent in 1708 for this very machine. Another invention was made in about 1764, by a poor man named Hargreaves; he called it a spinning *jenny*, and it is said that he received the original idea of it from seeing a common one-thread spinning-wheel overturned upon the floor, when both the wheel and spindle continued to revolve; this suggested to him the notion of making a frame in which a number of upright spindles should revolve side by side, and all be turned by the motion of the wheel. At first only eight spindles were attached to a frame, but more were added and many other improvements made. These two machines were used to spin all the cotton yarn up to the year 1779, when another improved machine, called the mule-jenny, was invented by Mr. Samuel Crompton, who was himself a weaver, and worked his new machine with his own hands in an attic. The great feature of this new invention was, that it stretched the yarn very gently and steadily after it was twisted, and this produced a much stronger and finer material than any that had been made before. Until the use of this machine it was thought impossible to spin more than eighty hanks of thread, each measuring eight hundred and forty yards, from one pound of cotton, whereas *with it* three hundred and fifty hanks of the same length have been spun from the same weight.

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* Baines's "History of the Cotton Manufacture."

After the thread is spun, how is it woven into Cloth?

It is woven in a *loom*, which is merely a contrivance by means of which a number of threads, the length of the piece intended to be woven, are stretched out, side by side, in such a manner, that every alternate thread can be raised and lowered by treadles placed below the loom, and worked by the weaver's feet; these threads form the warp; the woof, or shoot, is thrown in by means of a small pointed shuttle; under one thread and over the next, the weaver moves the treadles, and the contrary threads of warp are raised, and the shoot thrown through again; there is also a long stick, called a batton, by which the thread just woven in is driven up close against the one before it, so as to make the texture firm and close.

Are there not many improvements on this simple contrivance?

The hand-loom in use a hundred years ago was a more perfect machine, but it differed nothing in principle from the earliest and simplest loom; nor was it till the improved modes of spinning, already described, had rendered the materials for weaving abundant, and the demand for woven fabrics exceeded the power of supply, that any great improvements in the loom were devised. On the invention of the steam-engine by Watt, or rather on his application of it to other uses than that of raising water from mines, it was applied first to turn the spinning machinery, which had hitherto been almost exclusively turned by water-power, and afterward to the more complex operation of weaving by means of the *power-loom*. The hand-loom weavers in England, who had previously attempted to crush the various new spinning machines, rose in a body and destroyed all the power-looms they could, and for a long time the prejudice against them was very great.

What more is done to the Calicoes, after they are woven?

They have then to be bleached, which was formerly done by soaking the cloth in alkaline lyes for several days, washing it clean, and spreading it on the grass for some weeks, this was repeated five or six times, the cloth was then steeped in sour milk, washed, and again spread out on the grass. These processes occupied from six to eight months, and a great deal of space as well as time. Chloride of lime is now used, and the operation can all be performed in the factory, and in a few days instead of months.

How are cotton cloths printed?

A polished copper cylinder several feet in length, varying with the width of the piece to be printed, and three or four inches in diameter, is engraved all over with a pattern; it is then placed in a press, in such a manner that its lower side as it revolves comes in contact with the coloring matter, which is scraped off the surface of the cylinder by a steel blade called a *doctor*, the calico or muslin to be printed is then drawn tightly over the roller and the pattern is printed upon it. When two or more colors are to be introduced, a cylinder is prepared for each color, and they are placed side by side so that the fabric passing over them receives the whole pattern almost at the same moment. The saving of time by the use of cylinder printing machines is immense; one machine, attended by one man and a boy, can produce as much work as could be done in the same time by one hundred block-printers, and as many attendant boys, according to the old process.

What was the old process?

Blocks of sycamore-wood, about ten inches by five, had the pattern cut on their surface after the manner of wood-engraving. The block had a handle on the back by which it was held; its surface was applied to a woollen cloth, which was stretched over a vessel containing color, and was consequently saturated with it, and the block was then laid upon the cloth to be printed and struck with an iron mallet; when there were several colors used in a print the whole process had to be repeated for each color, which rendered it both tedious and expensive.

Who invented this mode of Printing?

The inventor of this process is not known, nor even the country in which it was first used, but there is reason to suppose that, like the arts of spinning and weaving cotton, it came from the east, for though in many parts of India the patterns are usually, if not always, drawn with a pencil or reed, there are other places, as at Orfah in Mesopotamia, where the calico is printed with small wooden blocks. Several other of the processes used in printing are of Eastern origin and of high antiquity. Thus printing with mordants is accurately described by Pliny, as being practised by the Egyptians: "Garments," says he, "are painted in Egypt in a wonderful manner; the white cloth being first smeared, not with colors, but with drugs which absorb color. These applications do not appear on the cloths, but when the cloths are immersed in a cauldron of hot dyeing liquor they are taken out the moment after, painted. It is wonderful that although the dyeing liquor is only of one color the garment is dyed by it of several colors, according to the different properties of the drugs which had been applied to different parts· nor can this dye be washed out. Thus the vat, which would doubtless have confused all the colors if the cloths had been immersed in a painted state, produces a diversity out of one, and at the same time fixes them immovably." A better description than this could hardly be given of the modern processes of printing with mordants, and what are called resist-pastes.

What are Mordants?

The term mordant is applied to those substances with which a cloth must be saturated before the coloring ingredient will so adhere to the cloth as not to be removed by washing; the name is also applied to those substances which can alter the shade of any color—*brighten it*, as it is called. Calicoes and muslins are often printed with a mordant, and then dyed, when the color appears on the printed parts as described by Pliny. Another mode of printing is to dye the article, and then print a pattern over it with some chemical substance, which has the power of discharging the dye, thus leaving a white pattern on a colored ground.

What is meant by Damask?

Damask is a kind of cloth with a pattern woven on it, sometimes made of flax, in which case it is used for table linen; sometimes made of silk, or of a mixture of silk with cotton, flax, or wool; worsted damask is all wool. Damask derives its name from having been originally brought from Damascus. Silk damask, which was for a long time used for all state dresses, was first woven in England by the Flemish weavers who fled there for refuge in 1567; it was very costly from the quantity of silk employed. Good linen damask was formerly all imported from Germany.

What are Muslins?

The name is now always applied to a very fine, thin, and transparent fabric made of cotton, but it is stated that the first materials which were called muslins, from being made at Mosul in Mesopotamia, were not made of cotton; Marco Polo speaks "of those cloths of *gold and silk* which we call muslins."

How is Cotton cultivated?

The seed of the herbaceous kind is planted in March, April, and May; and the cotton is gathered by hand a day or two after the pods burst, which is in August, September, or October. It is carefully planted in rows five feet apart, and with a foot and a half between each plant; it is well weeded, thinned, and pruned. In India the cultivation is much more careless, and the quality of the cotton is consequently very inferior. A field of cotton ready for gathering is very beautiful, when the globes of snowy or cream-colored wool are relieved against the dark glossy leaves; and in the hottest climates this effect is still further heightened by the beautiful yellow or purple flowers being still out on many plants, while others bear the ripe cotton.

What is the Cotton-gin so frequently alluded to?

It is stated that all the countries in the world could never have prepared for use the quantities of cotton now consumed had it not been for the invention of the cotton-gin, by Mr. Eli Whitney, of Connecticut. Cotton that required a hand a day to clean a pound, by this machine could be prepared better for market at the rate of three cwt. per day. The cotton is seized by rows of teeth formed of strong wires projecting from a roller, or by teeth like those of a saw, made upon circular plates of iron. These pass between grate bars, set so closely together that the seed cannot pass through, but the cotton is drawn in, and afterward swept off by a cylindrical brush. The importance of this invention cannot be overrated. It gave an impetus to the cultivation of cotton, and consequently its consumption, that revolutionized the industrial interests of the country.

Does Cotton ever grow on trees or shrubs?

Yes, there is both tree and shrub cotton; the former grows in India, China, and Egypt, and some other parts of Africa. The cotton shrub is more cultivated than the tree, and more closely resembles the herbaceous kind.

Where does the best Cotton grow?

On the sandy shores and small low islands along the sea-coast of South Carolina and Georgia. The cotton-plant likes a dry sandy soil, with a great admixture of salt, and if the plants be within the influence of the salt sea spray, the fibres of the cotton will be longer and finer in consequence. This best kind of cotton, which is commonly called *Sea-Island Cotton*, is much longer in its fibre than any other; it is strong and even silky in texture, and has a yellowish hue. It is believed that Persia is the native country of this species of cotton.

What is Silk?

Silk is the produce of a little caterpillar, being the substance of which the cocoon is formed, in which it reposes during its chrysalis state?

What do you mean by its chrysalis state?

All the insects which we call butterflies or moths, of which the silk-worm is one, pass through two stages of existence before they arrive at their perfect and final form; first, they are worms or caterpillars; then they pass into some sort of chrysalis, in which state the functions of life appear suspended, some of them bury in the earth, others make themselves cases of various materials in which to sleep till the time for their change comes; the silk-worm, at this time, spins itself a hollow oval ball of golden-colored silk. This period of sleep being past, the perfect insect emerges a beautiful butterfly, glittering in all the colors of the rainbow, and basking in the sunshine; or a soft and downy moth flitting through the evening shadows.

Is the moth of the silk-worm very beautiful?

By no means, it is a quiet grayish moth, with no beauty to recommend it, and not very active either, its sole business appearing to be to lay the eggs which are to furnish the next crop of useful spinners; these eggs are about the size of a grain of mustard-seed, and care is required in hot climates that they do not hatch before the time when their natural food is ready for them. In cold climates, there is no care of this kind necessary, as they need artificial heat to hatch them.

What is their natural food? will they not eat any green thing like other caterpillars?

The silk-worm in a wild state feeds only on the leaves of the mulberry tree, *Morus*, and though it will eat the lettuce and some other things, it never thrives; nor is it singular in this, for many other kinds of caterpillars are found only or chiefly on one tree or plant, which is their favorite food. There are several kinds of mulberry trees, the black-fruited, which is common in this country; the white-fruited, which is supposed to come from India or China, and which is vastly preferred by the silk-worm to any other species; the red-fruited, and several others. It seems to be a curious fact, that no other insect will eat the leaves of the mulberry-tree, and though every other tree in a garden may be devoured and blighted by insects, the mulberry-trees will escape uninjured. In the south of Europe, it is considered that a well-grown mulberry-tree will yield thirty pounds of good leaves in each season, without spoiling the tree.

Are the Caterpillars turned out upon the trees, or are the leaves gathered for them?

The latter practice is almost universal, indeed, the trouble of gathering the cocoons would greatly surpass that of gathering the leaves; still in some of the hotter parts of China the silk-worms are said to be allowed their freedom, man merely taking care that a sufficient number of eggs are hatched; and coming, when the little spinners have completed their work, to gather in the beautiful golden harvest. This silk is said, however, not to be so fine and good as that spun when the worms are carefully tended indoors.

How is this done?

The eggs are hatched by artificial heat. The old plan for accomplishing this was for some person to wear them next their bosom for three or four days; but the present plan is to place them in a room the temperature of which is gradually raised, until the tenth day it reaches eighty-two degrees; when the eggs turn whitish it is a sign they are nearly ready to be hatched; sheets of perforated paper or pieces of clear muslin are placed over the eggs, and the tiny worms as they come out of their shells climb through to the upper surface of the paper or muslin. Small twigs of mulberry are placed on the paper, and as the little nurslings climb on to these they are carried away to the rearing-house and other twigs are laid on. Great care is taken that the room in which the worms are kept should be well ventilated, and they are fed with young leaves chopped small. The silk-worms grow very rapidly; at first they are little black threads, small enough to be coiled in a shell not bigger than a mustard-seed. After one has grown for about eight days it refuses food, appears sickly, and pines, and in three days completely changes its skin, throwing off the old one which had confined it; it then grows rapidly again until the time of its second moulting, when it again refuses food, again casts off its skin, and increases very rapidly in bulk. This operation is repeated once more, and after the final moulting the worm is sometimes almost three inches long, and six will weigh an ounce; whereas when they were first hatched fifty thousand weighed no more.

How does it act when it is ready to spin its silk?

Little artificial hedges of twigs are formed upon the shelves on which the worms have been fed, and when they are quite ready, and have no longer any inclination to eat, they climb among the twigs and seek a convenient place for forming their cocoons. They first spin thin loose threads, and inside these they form a hollow ball, firm and elastic, and capable of being unravelled into one continuous thread, varying in length from three hundred to six hundred yards. The length of a cocoon is generally about one inch, and its width about two-thirds of an inch; this is measured without the external loose floss silk, which, with some part of the cocoon, can never be reeled off, but has to be spun in the same manner as cotton. The cocoons are either white or yellow, those which are the latter hue contain the most of a peculiar gum which stiffens the silk, and with which the worm smears the interior of its cell when finished, to render it both air and water tight. The emission of all this silk, which has been secreted in two spiral vessels contained in the stomach of the worm, greatly reduces its size, and when, at the end of three or four days, the cocoon is completed it rests awhile; and then changes its last caterpillar skin for the chrysalidan form, and would, if undisturbed, emerge in about fifteen or twenty days a moth.

When is the silk taken?

Usually in about seven or eight days from the time when the cocoons were finished. Great care must be taken to handle them gently, and to sort them very carefully, selecting some of the best to be preserved for the eggs. The perfect cocoons are put by themselves, and those which are soiled, double, or by any means imperfect, are sorted also. It is customary to kill the chrysalides in all those which are intended to be reeled, by exposure to great heat, and after this has been done the balls are stowed away on shelves in rooms intended for the purpose, great care being taken that no rats or mice should be able to enter, as they are immoderately fond of eating the chrysalides, and would spoil the silk in attempting to reach them.

How much good silk is obtained in proportion to the whole quantity?

In the average not more than one pound of reeled silk can be obtained from twelve pounds of cocoons; some of the difference being occasioned by the weight of the chrysalis, and the remainder by the floss or refuse silk.

How is the silk reeled?

A little machine turned by hand is employed, which contains a large reel to form the skein of silk, this is usually about one yard in circumference, with a wheel which guides the thread to and fro in the same manner in which sewing-cotton is wound on reels. Attached to this is a small boiler, about eighteen inches long and six inches deep, under which a small charcoal fire is made; into this boiler the cocoons are thrown when the water is nearly boiling, and after a few minutes their gum is sufficiently softened for the loose filaments to float off. The reeler takes four or more of these in her hand, and twisting them together they adhere by means of the softened gum, and when attached to the reel are wound off as one thread; by this means their strength is greatly increased. When the thread from one cocoon breaks it is not needful to tie a knot, the gumminess of the silk being sufficient to unite the ends; and great care must

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be taken by regulating the number of threads wound at once, that the thread produced be of uniform size throughout.

What is done next after reeling?

The silk is sent to a mill where it is worked from raw silk into *singles, tram,* or *organzine;* singles is merely made by *twisting* the raw silk; for the formation of tram two or more threads are twisted together (this kind is used for shoot or weft); while organzine is a real though fine *cable* made of silk, it being composed of separate cords, each of which has previously been twisted; organsine is principally used for warp. This operation, which is technically called *throwing,* was for a long time exclusively carried on in Italy and the south of France; and, although there are now some excellent throwing-mills in England for some descriptions of silk goods, Italian organzine is very much preferred.

When the silk has been twisted into organzine, it is quite ready for weaving, I suppose?

No; the silk thus thrown is called hard silk, and must be boiled with soap in order to discharge the gum; for unless this were done the silk would be harsh to the touch, and unfitted to receive the beautiful dyes which are always given to silk before it is woven. The boiling, which lasts four or five hours, lessens the weight, but increases the bulk of the silk, and renders it soft and glossy.

How is Velvet made? it is a silk manufacture, is it not?

Yes, velvet is made of soft organzine silk, and is woven with a loose pile in addition to the warp and shoot—that is to say, there are a great number of additional threads running in the direction of the warp, which are caught in by the shoot, after having formed a loop over a wire used for this purpose; another loop is then formed over another wire, and the first one is cut out by running a sharp instrument along a groove made for this purpose in the wire; this operation, of course, leaves a number of tiny bunches of silk sticking up over the surface of the fabric, and these are so thick, and so close together, as to cause that soft and beautiful face which velvet

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is remarkable for. An inferior kind of velvet is sometimes woven of cotton. Terry velvet is made with the loops uncut; the effect of which is to make it look more like a silk very much ribbed than a velvet. Velvet was first woven in Italy; Genoa, Milan, Venice, and Lucca, were famed for its manufacture, the first city having long given the name to the best kind; but the French artisans learnt the art from their neighbors, and soon excelled; and by some of these, who were expelled from their homes by the revocation of the Edict of Nantes, the art was first established in England, where it has since been successfully pursued.

Are there not many other curious and beautiful materials made of Silk beside Velvet?

Yes, formerly there was a great deal of gold and silver brocade made, which ladies wore for state dresses; these had a pattern woven on them in one or other of these metals, on a ground of silk; these materials, which are nearly extinct now for dresses, have been recently introduced again for ribbons, and the effect produced is very good indeed.

Where are Ribbons made?

English ribbons are chiefly made at Coventry; French ribbons are made at Lyons, St. Etienne, and several other places; it is customary to weave several pieces of ribbon in the same loom at the same time, by means of a contrivance by which the separate shuttles required for so many separate pieces may all be driven by the same stroke.

Where did Silk originally come from?

Silk is described in ancient writings as coming from Serica or Sereinda, which were names applied to that part of India which lay beyond the Ganges; and it is said to have been the produce of a people whom they called the Seres, and whom there is good reason for identifying with the Chinese; certain it is that this remarkable people had brought the silk manufacture to a very high degree of perfection before it was at all known in any other country; and this alone would prove it to have been no modern invention among them, as

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they are proverbially rooted to old customs, and learn any new art with difficulty. Until the time of the Emperor Justinian all the silk used in Europe was imported, either in the state of raw silk, or woven by the Chinese into stout, substantial fabrics. These latter were either worn as they were imported, or they were unravelled, and rewoven into a gauze fabric by the women of Kos, an island in the Archipelago; this, which appears to us now as a most tedious and profitless employment, was long pursued, and with great success; nor will it seem so wonderful when we are told that the value of silk during a great part of this period was *its weight in gold.*

What made it so costly?

The immense distance it had to traverse without any of the facilities of transit which modern science has invented; and also the number of hands it passed through, all of whom expected to be largely rewarded. The greater part of the trade in silk with China was conducted by the Persians, who derived from it much of the wealth and luxury for which they were celebrated.

How came the Silk-worm to be brought to Europe in the reign of Justinian?

The story of its introduction is this:—the Romans were at war with the Persians, and their supply of silk from this source being cut off, they sought unsuccessfully to obtain it through other channels. About this time two monks, who had been as missionaries to India, and had penetrated to China, returned to Constantinople, bringing with them the news that this wonderful *Sericum*, which was its Latin name, was the produce of a little worm which changed into a moth; they had observed, and could describe many of the processes by which it was prepared for use. The Roman emperor offered them great rewards to return and procure some of the eggs of this wonderful worm, which they did in 552, though at some hazard of their lives, and the comparatively few eggs which they brought concealed in a hollow stick, were the stock from which all the silk-worms since reared in Europe are descended. The introduction of the real insect into Europe banished all the fables which had till that time been current as to the origin of silk—such as that it was combed from the leaves of trees, from their bark or flowers, or that it was the produce of spiders or beetles.

Where was the Silk trade carried on in these early times?

For about six centuries after the silk-worm was naturalized in Europe, the silk manufacture was almost exclusively confined to the Greek empire; but on its invasion by Roger, first king of Sicily, some of the artisans were transplanted to Palermo; from this point it gradually spread over Italy and Spain. France, which now rivals if it does not exceed all other nations in this branch of industry, did not enter the list until the reign of Francis the First, who was contemporary with Henry the Eighth. England was still later, at least in the production of any thing larger than "laces, twined ribbons, and girdles," which are incidentally named in a statute of the 8th of Henry the Fourth.

Where is the Silk which is woven in England obtained?

A large quantity comes from the south of France, from Italy, and some from Turkey, and the countries bordering on the Levant; raw silk is also imported to a large amount from China, and from the East Indian dependencies. Many attempts have been made to rear the silk-worm in colder climates than those of which it is a native, but all have proved unsuccessful as to any profitable results. In the earlier days of the settlement of America the culture of Silk was tried in Virginia, and afterward in Georgia and South Carolina; but owing to various causes, chiefly the high price of labor, it did not succeed, and in a little time the increase of the demand for cotton, which was a much more productive crop, banished the silk entirely.

What is this piece of Irish made of? it looks different to calico.

It is made of linen, which is much stronger, and can be made much whiter than cotton. Linen is the woody fibre of the stems of the flax, *Linum usitatissimum*, an annual plant about eighteen inches high, which bears a pretty blue flower; this, when it falls off, is succeeded by a seed-pod containing eight or ten brown flat seeds. These seeds are useful, for they contain a large quantity of oil, which is pressed out and used both in the manufactures and painting; and the residue, after the oil has been squeezed out, forms an excellent food for cattle; it is called oil-cake.

Where is Flax grown?

In this country as well as in England and Ireland; but more than one half the whole quantity which is employed in the English linen manufactures comes from Russia, and some also from Holland, Belgium, and Prussia. The best flax comes from the neighborhood of Courtray, in Flanders, where a finer variety is grown, which is so long and slender as to require support while growing; the inhabitants, too, pay more minute attention to its cultivation than is the case in many other places, and finer crops of better flax are their reward.

Is it a great deal of trouble to grow?

No; it requires rich, light soil, and a large quantity of manure; the seed is sown early in spring, and the crop is ready to be gathered early in the autumn; this is done by carefully pulling the plants out of the ground by hand; they are then laid to dry for a few days, and afterward gathered into miniature sheaves, which are left some time longer to dry before they are stacked. The value of the flax very much depends on having fine weather during this drying.

What is done to the flax after it is dried?

It is next steeped in water, which has the effect of rotting off the bark and all the green part of the stem, leaving the fine long fibres free. This steeping used to be performed in dirty stagnant ponds, which, though they hastened the accomplishment of the desired object, injured the color of the flax; running water is therefore preferred, and the river Lys, in Flanders, is much resorted to for this purpose. After the steeping has been carried far enough to rot off all the extraneous matter, it must be stopped at once, as any continuation of it would injure both the strength and color of the linen. When taken out of the water, it is laid in rows on a smooth piece of grass to dry, here it lies about a fortnight, being frequently turned over. When dried, it is packed away for the breaking and scutching to be done, when the leisure time comes for the little farmers, who are the chief growers of flax.

How is Flax scutched, and why is it done?

The object is to free the fibres from the remaining pieces of wood, &c. The old-fashioned scutching machine was only an upright board made steady, and with a slit across it at about three feet from the ground; the flax was drawn through the slit with the left hand, whilst with the right it was beaten with a wooden sword called a scutcher. A mill is now employed for this operation, which saves a great deal of time and trouble, and has lessened the expense of preparing flax for use. After scutching it is *hackled* or *heckled*, which is the same in effect as the combing of cotton and wool, namely, drawing it over a number of long spikes, by which its fibres are separated and smoothed, all being made to lie one way.

How is Flax spun?

Until a very recent period little machinery was used in making linen cloth, the distaff, or spinning-wheel, was sufficient to spin the thread, and the hand-loom in its simplest form was employed to weave it; but the inventions of Arkwright and others in the cotton manufacture have been, with some modifications, applied to that of linen—so that mill-spun yarn is now always used and the power-loom is employed; this has materially reduced the price of all linen materials, from the coarsest to the finest.

Which is the most ancient, Linen or Cotton?

In every country of the old world, except India, linen has far exceeded cotton in antiquity; indeed it seems to have been the earliest substitute for the skins of animals, as an article of clothing in warm climates, as wool was their earliest substitute in colder regions. Egypt was the first cradle of the manufacture of linen; it was made there in perfection before the days of Joseph. All the mummies which have been examined are found wrapped in linen cloths, and the fine linen is mentioned as one of the exports from that country; the Egyptians not only excelled in the art of spinning and weaving linen, but they dyed it blue and purple and scarlet, and ornamented their garments with *broidered work.* The Hindoos possessed the flax-plant and used its seeds for oil, but never employed the fibres; and the same may be said of the aborigines of Central America.

What is Hemp?

Cannabis sativa; a plant allied to the common nettle, the stem of which produces a kind of fibre much stronger than that of flax, and which is cleaned and prepared in a similar manner; on account of its great strength it is used to make rope and cables, sacking, and all sorts of coarse strong cloths, sheets, &c.; and some of the finest is made into linen, which is for many purposes preferred to that made of flax, being so much more durable, but it is never so white or so fine as the best flax-made linen. The chief supply, both in its raw and manufactured form, is from Russia, where it is very extensively used and cultivated.

What is Wool?

The fleecy coat of the sheep which is shorn off in the summer; and, when carefully cleaned from grease, is spun and woven into cloth, blankets, flannels, stuffs, carpets, and all the countless materials which are known as woollen goods.

Is the sheep the only animal which yields wool suitable for this purpose?

No; there are various species of goats whose fleeces are even more valuable than that of the sheep; as the wool, which is long, fine, and silky, is suited to the manufacture of the most beautiful shawls and other articles of ladies' dress. The Cashmere, or Thibet shawl-goat, which inhabits the mountains of those countries, has a large head, long slightly-bent horns lying backward, a straight back and delicate limbs; the coat consists externally of long coarse hair, which covers and conceals the fine soft wool; in the spring, after the shearing, these are separated, and the wool, which is gray, is washed, bleached, and, if intended for making colored shawls, is dyed once before carding and once again before spinning. The Cashmere goat is generally reared by poor families, and becomes the household pet, as well as their chief dependence for support; the females spin the yarn, and the men weave the shawls in rude hand-looms, without any of the appliances of modern art, which have so much simplified the weaving of rich patterns; yet Europe is only beginning to rival the beautiful productions of the East. Other species of these goats are found at Angora and Ancyra. The Llama, too, which is an animal inhabiting the Andes, has a very long, soft, and valuable fleece; and many other materials of this kind are yearly being discovered and brought into use.

Is the wool trade and manufacture of modern date or not?

Oh, no; wool was the first material that succeeded skins as the covering of our semibarbarous ancestors; and in all the colder countries woollen garments were the first made, and continue to be those chiefly employed. The wool trade was one great source of revenue to the English kings, by means of various taxes and imposts, all of which were injurious to its progress.

How is the cloth of which gentlemen's coats are made, caused to look as though it were not woven?

For this material, which is called *broadcloth*, a curious operation is performed after the weaving is complete. The surface of the cloth is *teased*, that is, a number of small fibres are drawn to the surface so as to hide the warp and shoot. The seed-vessels of the teasel, *Dipsacus fullonum*, are used for this purpose; they are conical heads furnished with a great many hooked spines; a number of these heads are placed on a kind of drum so as to form a continuous card, which revolves over the surface of the cloth until a sufficient *nap*, as it is called, is raised; it is then smoothed down and pressed. It is said that various machines have been devised to use instead of the teasel-heads, but that they all fail because they cannot be made of any material which shall, like the teasel, break as soon as considerable resistance is encountered, and before a thread has been drawn out too far; so constant is this breaking that fifteen hundred or two thousand heads are not unfrequently employed in dressing one piece of cloth. Only the cultivated teasel can be used for this purpose, as the wild one, though it has abundant *spines* has no *hooks*—only by culture do they become recurved. Teasels are a troublesome and uncertain crop, and are mostly grown by speculators: they are sown in April and are cut in July, each one separately, with a knife; they are dried in the sun, and sorted into kings, middlings, and scrubs, according to their size.

Of what are Carpets made?

Of wool or worsted principally, but cotton and linen are both used in the manufacture of some kinds.

What nations first used Carpets?

The eastern nations; carpets are to the Persian, the Turk, or the Arab, one of the necessaries of life; they form, with his cushions or divan, all his furniture: his seat, his bed, his table; he must have his prayer-carpet spread out, on which to kneel at the appointed hour; he must have his smoking-carpet, on which to recline and dream away his time; there must be a carpet for the harem of the rich and for the tent of the poor.

How are the Oriental Carpets made?

Those which are known here as Turkish and Persian carpets, are woven by hand, mostly by poor peasant women; the loom is the simplest and rudest that can be imagined. The carpet is woven the whole size it is intended to be, and the raised part or pile is formed by knotting in tufts of fine soft woollen yarn, a row of tufts being fastened to the warp between each throwing of the shuttle. The Persian women fill up the time with working at their carpet-looms, tastefully forming the pattern as they proceed from designs of their own, which are generally gay mosaics, where the colors are beautifully blended.

Are these Carpets brought to America?

Yes, the poor people who make them, sell them at the nearest bazaar, where they are bought up by the Persian or Turkish merchants, who take them to Smyrna, from whence they are exported to the various cities of Europe and America.

Have carpets long been in use with us?

A hundred years ago carpets were hardly used at all by the middle and lower classes, and the rich spread small pieces in the centre of their best rooms; but long before this time, as early as the days of Edward I., we hear of carpets, often of very rich and costly materials; of gold brocade, of velvet with gold or silver fringe, or of needlework; for the tapestry that was used to hang round the walls was not unfrequently laid upon the floors too, and our ancestors sometimes laid carpets of "fyne purpoure" (purple) on their beds.

What was the common covering of floors during those days when carpets were rare?

Fresh straw or clean rushes, which however did not long retain their freshness; the halls were often covered with these when the bedrooms and bowers of the ladies were carpeted or matted; carpets were laid down, too, before the high altars in churches and abbeys, and there were throne-carpets, bed-side-carpets, and hearth-rugs, all through the fourteenth and fifteenth centuries; in the following century small woollen carpets were woven for the court and nobles, which had coats of arms in the centre.

What are the different kinds of English carpets, and where are they made?

The Axminster carpet, made at Axminster, in Devonshire, is the most costly of British manufacture; it closely resembles the Turkey and Persian carpets already described, the pile being knotted in the same manner. The Kidderminster carpet is made both in that town and in Yorkshire and Scotland. This kind is made by two separate webs of different colors woven simultaneously, the pattern being formed by bringing to the surface the web of the desired color, while the other passes at the back; thus it follows that the pattern is the same on both sides of the carpet, but the colors are reversed—in this carpet there is no pile.

Is the Brussels carpet of foreign manufacture?

This most important kind is extensively made both at Kidderminster and in Scotland; for Brussels carpets the warp and shoot are both of linen, the worsted is bound firmly in between the upper and under shoot; there are mostly five different colors of worsted, two threads in thickness, and the pattern is formed by bringing to the surface a row of loops, each loop of one of the five colors; when this is effected, a wire is run in to keep them up firmly. The Wilton carpet differs from this only in having a groove along the upper surface of the inserted wire, along which a sharp knife is run, and the loops cut, thus making a soft pile. Wilton and Brussels carpets therefore bear the same relation to each other, that common velvet and terry do. Dutch and Venetian carpets are also made; they are coarse and cheap kinds, differing but slightly from each other.

Are not many other things made of wool beside those you name?

Yes, a very great many, but having explained to you the process of spinning and weaving in describing cotton, it would be tedious to repeat it for wool, the operation being performed mainly in the same manner, though with some slight variations. Beside the numerous articles of clothing made of wool alone, a great many materials are now made by a mixture of wool and cotton, or wool and silk; sometimes they are spun together, but more frequently the warp is of one substance and the shoot of the other. Of this kind are all the thin summer dresses of our ladies, called bareges and balzerines, as well as more substantial articles.

The fabrics composed of woollen alone, in addition to *broadcloth*, which has been described, are mainly as follows: *kerseymere*, or cassimere, a twilled cloth, possessing a greater degree of pliability than cloth, from its peculiar texture; one thread of the warp is always above and two threads below each shoot of weft; *tweed*, a light fabric employed for summer-coating; *flannel*, a loosely woven stuff, used as warm clothing; *blankets*, which derived their name from Thomas Blanquet, who introduced them in 1340; *baize*, a coarse open fabric having a long nap, sometimes frizzed on one side and sometimes not; it was first introduced into England by the Flemings; *plush*, a stuff having a sort of nap on one side composed of a woollen thread, and a warp of goat's or camel's hair; *moreen*, a very stout stuff made for furniture. This latter comes distinctly under the classification of *stuffs*, the most important distinction of which is, that they have not their surface covered with a nap or pile. They are woven either plain or twilled, or spotted, or figured, but in all their varieties the thread is left bare. "After the operation of weaving, each side of the piece is drawn rapidly over a convex plate of red-hot iron to singe off the superfluous fibres of wool; it is then rolled tight, soaked in hot water, and boiled; afterward it is scoured, and pressed between rollers to take out the moisture." It is then ready for the dyer. Stuffs include all the thin fabrics such as shalloons, tammies, plaids, merinos, serges, etc. *Merino* is an extremely fine twilled stuff woven of the finest wool, in the manufacture of which the French excel: *mousseline de laine*, is a new species of light woollen fabric, first introduced from France. *Plaid* is a term often applied to the color of stuffs, whereas the term means a peculiar ancient dress worn in the Highlands of Scotland. It is always made of a checkered pattern of various colors, there called *tartan*. Tartan is the name of the color;

plaid is that of the dress. Instead, therefore, of saying "plaid ribbons," we should say, "tartan ribbons." The true Scotch plaid is a coarse, strong stuff, well calculated to keep out the wet.

Will you enumerate some of the principal linen fabrics?

Drill, a stout twilled linen made for summer trowsers; *dowlas*, a strong, coarse Irish linen cloth; *cambric*, an extremely fine and beautiful fabric, the name of which was derived from the city of Cambray, where it was first manufactured; *lawns*, originally of French manufacture, are thinner and more transparent than linen, but not so much so as cambric and others, such as *linen damask*, *tick*, etc., etc.

Of the cotton fabrics, there are, *chintz*, a peculiar style of printed calico, in which the figures are of at least five different colors; *jaconet*, a fabric somewhat lighter than muslin, very open and soft, the name of which is supposed to be a corruption of Juggernaut, a district in India, where they are chiefly made; *gingham*, a thin, checkered muslin; *jean*, a twilled cotton, striped as well as white; *corduroy*, a ribbed or corded stuff, the projecting part having a pile. The corded appearance was originally produced by cutting or cropping the surface by hand, but a machine now performs this delicate and laborious operation.

What is Poplin?

A mixture of worsted and silk, for the manufacture of which Ireland was once so famous. It contains more silk than bombazine, which is composed of the same materials. Superb patterns of this material have been manufactured on gold, silver, and tinted grounds, with flowers of every variety of color.

What is Gauze?

"A transparent cloth made of fine silken threads. The peculiar character of gauze-weaving is, that between each cast of the shuttle a crossing of the warp-threads shall ensue, and thus the weft (which forms the cross-thread interlaced by the warp) is not brought into absolute contact with the cross-thread immediately preceding. The intervals left between the interlacings cause that degree of transparency, which, without such arrangement, could only result from a looseness of texture incompatible with beauty and utility."

What is Crape?

A light transparent fabric composed of silk, from which, by a mode of preparation, all the gloss has been taken. The wrinkled appearance of crape is produced by the application of a viscid solution of gum.

What is Taffeta?

A smoother silken stuff, having a waxy lustre, imparted by pressure and heat, with an application of an acidulous fluid to produce the effect called watering.

What is Camlet?

The true oriental Camlet is made of the pure hair of the goat frequent about Angora, and which makes the riches of that city; all the inhabitants being employed in the manufacture and commerce of camlets. But there are camlets so called, which are sometimes made of wool, sometimes of silk woven with goats' hair.

What are Brocades?

Originally this term was applied only to those silks into which gold or silver threads, or a mixture of these, were interwoven. They were highly esteemed by our ancestors, but now their use has been discontinued. The richest brocades appear to have been made in Italy, where an extensive manufactory of them was carried on during the thirteenth century. In the manufacture of gold brocade a silver wire is gilt, drawn out to a great fineness, and flattened. This is twisted around a silk thread, dyed of a color as near as possible to the metal, and interwoven in the fabric. Latterly the term brocade is applied to rich stuffs adorned with raised flowers, foliage, or other ornaments. The plan of introducing metals into the composition of fabrics was a taste originally oriental, where a love of rich and splendid stuffs prevails so extremely. In China and India it has long been the fashion to ornament silk and muslin with threads of gold and silver.

Are there any other materials than those you have named used in making Cloth?

There is a large mussel found on the coast of Italy, which spins from its body a fine web, very much resembling silk in its nature. It is called *Byssus*, and gloves, stockings, and other small articles are manufactured from it. The leaves of the pine-apple plant afford a fibre from which silken fabrics are made. *Glass* might be considered most unfit for this purpose, yet glass in a semifluid state is known to be one of the most elastic substances; its filaments can be made thinner than hair, and can be bent in any direction with safety and ease. An experiment has recently been made of this material, in which the spun-glass was employed, together with silk, in forming a splendid kind of brocade, on which the glass threads formed the figured pattern. "Nothing," it is said, "could exceed the beauty and richness of this new kind of cloth."

What is Lace?

A species of network made of silk, thread, or cotton, upon which, in old times, patterns were embroidered by the needle after its construction. They are now, for the most part, formed during the knitting itself. The best laces are made at Mechlin, Brussels, Antwerp, Ghent, and Valenciennes. Point-lace is that embroidered by the needle, and, from the great labor required, is the most expensive. In lace knit by hand as many threads are employed as the pattern and breadth require. These are wound upon the necessary number of bobbins made of bone (whence the name bone-lace) which are thrown over and under each other in various ways, so that the threads twine around pins stuck in the holes of the pattern (a stiff parchment stretched on a pillow), and by these means produce the openings which give the desired figure. In that made by machinery, the meshes are all formed by a continuation of a single thread. The origin of lace-knitting is uncertain. It may lay claim to high antiquity, even to classic origin. It was brought into France and the Netherlands from Italy, where its manufacture flourished for a long period.

About Metals.

We will take for the subject of our next chapter quite a different class of objects from any we have been considering before; let us take this poker, for instance—can you tell me of what it is made?

Of iron.

What is Iron; is it a natural or an artificial substance?

Iron is a metal, and is a natural substance, but is not found in the state in which it is used. Metals are seldom met with pure, but are found combined with earthy matter in the form of rock, with sulphur, carbon, etc., and in this state are called ores.

What are the peculiar characteristics of Metals?

They are mineral substances, which are opaque, and possess a peculiar lustre; they are fusible by heat, and do not become transparent during fusion; most of them are malleable—capable of being hammered out into sheets; ductile—capable of being drawn into wire; and tenacious, or not easily divided.

Which metal is the most abundant, and at the same time the most useful?

The iron of which our poker is made; its ores are scattered over the globe in every country, and in rocks of different formations, with an abundance which shows how admirably the resources of the earth are fitted to man's need. By far the greatest number of iron-works are situated in the counties of Stafford, Salop, York, and Derby, in England; those of Lanark and Stirling, in Scotland; and there are extensive works also in South Wales.

What countries have Iron-works?

Of the European nations, Sweden, Austria, France, Spain, Belgium, and Saxony, are the largest iron producers. The United States and Hindostan have valuable iron mines. In Great Britain there are extensive iron-works.

Was Iron discovered early?

The knowledge of working iron appears to have been early in some localities rather than universal; this was probably occasioned by the ores being so little like the metal, and by their great difficulty of fusion; the fact that *native* iron is of very rare occurrence, would prevent the people of those remote ages from becoming easily possessed of any of the metal in a pure state, as might have been the case with gold, etc.; had they thus found it, and learned its uses, they would have been induced to seek for more. One or two blocks of native iron are known to exist, but they are very rare. We read that Tubal Cain worked in brass and iron before the flood; and it appears probable that the Greeks possessed iron, and even the art of converting it into steel, at a very early period; but, as the words translated iron and steel may merely signify some hard metal, such, for example, as an alloy of copper and tin (which we know to have been often employed in ancient times), it is not easy to ascertain the date of the discovery.

When were the first Iron-works begun in England?

Cæsar states that the Britons, at the time of his invasion, possessed not merely iron tools and money, but were expert in the use and manufacture of chariots armed with scythes; this implies a greater advance in the arts than any vestiges remain to verify; but whether we credit it or not, it is certain that iron ores were worked there during the sojourn of the Romans in Britain; large and deep beds of scoria remain in many places to attest the fact, some of them covered with a thick crust of soil, in which are rooted trees of great age, and in not a few of these beds Roman coins have been found.

Where were these Iron-works situated?

They were scattered over the country; some of the *bloomaries* as they were called, were near the site of the town of Sheffield, where the iron ore has long since been worked out; some in the forest of Dean, in Gloucestershire; in Sussex; and at Furness in Lancashire, which is said by Camden to have derived its name "from the many furnaces therein in olden time."

What is Cast-Iron?

Cast-iron is the term applied to iron which has been melted and poured into moulds; it is the simplest form in which this metal is used.

How is it obtained?

The rough ore is first piled up with fuel and roasted in a kiln, which frees it from water, sulphur, arsenic, and other impurities which are capable of being *sublimed*—which means being driven off in fumes. The roasted ore is then smelted in a blast-furnace, which is charged from the top with certain proportions of iron ore, coke, and limestone; the last to act as a flux.

What is meant by a Flux?

It is a general term employed to describe any substance used to assist in the fusion or melting of minerals; limestone and fusible spar are used, also culm coal, &c.; and in the manufacture of glass, the soda and other alkalies employed act as fluxes. The name flux is derived from the Latin word *fluo*, which signifies to flow, the participle of which is *fluxus*, because when the mineral is melted it begins to flow.

How is the Iron Ore smelted?

As iron is one of the least fusible of metals, to attain the required degree of heat to fuse it, the fire is blown by forcing into it a current of hot or cold air; which is effected by machinery worked by steam power. The fluid metal is let out, from time to time, into channels, which form moulds for making "pigs," which is the term given to the rough pieces thus formed; this is the state in which iron is sold as a raw material.

How are cast-iron articles made?

A quantity of this pig-iron is melted in a furnace, and then the liquid iron, which looks like liquid fire, is poured out into moulds and allowed to cool very gradually. These moulds are usually made in a bed of fine wet sand; a curious instance of the employment of an apparently weak and fragile substance to mould or curb a strong one.

You said that cast iron was the simplest form in which we used the metal—what is wrought iron?

Wrought, otherwise called bar or malleable iron, is made from the rough pig-iron in this manner: it is first refined, which is chiefly done in the "puddling furnace," the iron being exposed to very great heat, and stirred about while a strong current of air plays over its surface; the intense heat consumes the carbonaceous matter remaining in the iron, and all the earthy impurities rise to the surface in the form of slag, and are allowed to run off. Gradually as the iron becomes purer, its fusibility lessens, and it becomes tough like dough, even though the heat of the furnace be undiminished; it is then withdrawn, and while still red-hot is beaten with the forge-hammer or subjected to rolling, by which means it becomes much more tenacious, from its particles being more closely compacted. This process converts hard, brittle, fusible pig metal into a tough elastic bar, very malleable, but hardly fusible at all.

Fusible, that means able to be melted; now if the iron can hardly be melted at all, how inconvenient it must be?

Yes; and it would deprive iron of one of the most valuable properties of metals, that of uniting smaller masses into one, were it not for a singular and useful quality which no other metal, except *platinum* and a new metal called *aluminum*, possesses; that of *welding*. If two pieces of iron be heated to a white heat, and applied together, they adhere, and may be perfectly united by forging; this is called welding. This malleable iron is the kind which is used by blacksmiths, being capable of assuming any shape under the hammer.

Is not steel made from iron?

Yes; bars of wrought iron are imbedded in pounded charcoal, and exposed to a furnace heat in close vessels; when withdrawn from the furnace the steel is found to have absorbed some of the charcoal, to be harder and more fusible, and its surface covered with small bubbles, hence it is called *blistered* steel; when several rods of this kind are heated together in a box with a flux, and afterward hammered into one piece, it is called *shear steel*, because it is the most suitable for making shears, scissors, etc. When this kind of steel is melted and run into ingots, it is termed *cast steel*, which is the most perfect form of the metal.

Then all three kinds of iron are made from one ore?

Yes; the same ore may be converted into any of these forms, though some ores are more suited to one kind and some to another; until comparatively recent improvements in the manufacture rendered it needless, all the iron employed for making the *finest* steel was obtained from one mine, that of Dannemora in Sweden.

Is the ore which comes from this mine so very good?

The iron is considered the best in quality, although some persons attribute its excellence more to the superior mode in which it is worked than to any thing in the native ore. The mine of Dannemora is beautifully situated in the province of Upsal, lying upon a hill-side, and surrounded by lakes; it was first attempted to be worked as a silver mine, but the less beautiful metal now found there has proved far the most lucrative, and the works have consequently been much enlarged. The vein of iron, which is very large, is distinguished by three distinct names, according to its situation, or the quality of the ore in different parts; it is chiefly worked by blowing it up with gunpowder. The miners are in the habit of firing many parts of the mine at the same time, which causes a dreadful shock almost like an earthquake. The mine alone is said to employ about twelve hundred work-people; and besides these, there are large numbers employed at the various neighboring establishments for smelting, hammering, and casting the iron. All these form the population of several villages, each consisting of three or four streets, and supplied with a church, school-house, and hospital.

What is meant by tempering steel?

It is plunged when red-hot into cold water or oil, by which means it becomes very hard, and can be made brittle and highly elastic; some things, such as a lancet, require the steel to be hard as adamant, but do not need strength, and break immediately; while for others, such as a trowel, the hardness must be associated with a toughness, which shall suffice to prevent it from breaking even with the roughest work; these extremes, and all intermediate stages, can be attained by regulating the processes of hardening and tempering. The most wonderful stories are told of the temper of swords and scimitars made at Damascus in the middle ages; and Andrea of Ferrara, who was supposed to possess the secret of the Damascenes, has left his name to blades of matchless temper; these swords would, it is said, curl up or bend in every possible manner without breaking, and yet such was their strength and keenness of edge, that not merely muscles and bones but common iron, steel and brass were severed by them without difficulty.

Could these beautiful swords only be made at Damascus and Ferrara?

Toledo, in New Castile, also obtained great celebrity in this manufacture, the secret of which was probably conveyed by the Moors; nor does the art appear to have died out. Toledo blades were shown in the Great Exhibition in 1851, which would bear, uninjured, insertion into a sheath in the form of a coiled serpent.

Did those wonderful swords look like those we generally see?

Not exactly, and they were generally ornamented with a variegated pattern of black and gray, or as it has been called, a *damask* on their surfaces; this was produced by welding an iron wire round the piece of steel intended for the blade, and afterward twisting it in various directions, or in some cases grooves were filed and the wire let in, in a pattern, and afterward welded—these patterns were rendered visible by the application of diluted acid.

How are needles made?

They are made of steel wire, which is reduced to the required fineness by being drawn through successive holes, each smaller than the one before; when fine enough the wire is cut into lengths, and each piece flattened at one end, in which flat part the eye is punched with a sharp steel die; the corners are next smoothed off, a little groove is filed on each side of the head, the point is filed sharp, and all roughness removed. The unfinished needles are now laid upon a piece of iron to be heated over a charcoal fire, and thrown while hot into water, to temper and harden them; as this process often renders them crooked they are obliged to be warmed and hammered straight again, and then require nothing more but polishing. This is done by rolling and rubbing immense numbers of them together, with oil and emery, after which they are well washed in hot water and soap, and dried in hot bran, the points are ground fine, and the needles sorted and packed.

When were needles invented?

The Spanish Moors are said to have been the inventors of steel needles; before which thorns or fish-bones, with a hole pierced for an eye, or some other contrivance equally clumsy, were generally used, as they are now by the women in the South Seas, and some tribes of Indians. The first needles made in London were made by a Moor, in the reign of Henry VIII.; and Stowe tells us that, in Queen Mary's days, steel needles were sold in Cheapside and other busy streets in London. After this time the manufacture increased rapidly, many Germans coming over to England, and establishing needle-works in villages in different parts of Warwickshire, and near Sheffield.

Here we have a tin cup—what is it made of?

Not of tin, as we might naturally suppose, but of a thin sheet of iron, covered with tin, to make it bright and clean, and keep it from rusting.

How is this done?

The iron is rolled out into very thin sheets, and these are made perfectly clean with acid from all rust or dirt; they are then dipped into melted tin, which covers them over with a brilliant and immovable pellicle of that metal.

What is meant by a pellicle?

A thin film or crust spread evenly over the surface of any substance.

What advantages do these tinned articles possess?

Beside their cleanliness and durability, they have the advantage of being very light. Block-tin is the same material, hammered afterward and *planished*, that is, beaten on a metal stake with a polished steel hammer till it is perfectly smooth and bright. Many small articles, such as nails, bits, and common stirrups, are first cast in iron, and then thinned.

At present, however, you have only told what it is that we usually call tin in speaking of manufactured articles—what is tin itself?

A white metal, bright and silvery; it is elastic, and consequently sonorous; ductile, very light, and it fuses at a much lower temperature than is necessary to heat it red-hot.

Where is tin found?

Tin is found in America, England, and some parts of Germany; but the largest supply comes from the Malay peninsula and the adjacent islands; this is called Banca tin from the place of its export.

Are not the English tin mines very ancient?

Yes; they were the first discovered of their mineral wealth, and early attracted more civilized nations to their shores; the Phœnicians traded there for tin six hundred years before Christ, and are said to have first given a name to Cornwall, in which county the tin mines of England are chiefly situated, calling it from its form and projecting position by a Phœnician word, which signified a *horn*, from which appellation are derived both the Latin *Cornubia* and the English Cornwall. The Greek colonists at Marseilles, and the Romans, came also to England for tin, and these last gave the name of Cassiterides, or Tin Islands, to the Scilly Isles, or perhaps to St. Michael's Mount, and some adjacent rocks, where, as Diodorus Siculus relates, the natives carried their tin in little carts at low water, to barter with their more civilized visitors for the much-coveted produce of southern climes.

Were these ancient mines deep excavations?

No; they were probably stream-works open to the surface, where the metal is exposed by washing. Pickaxes of holm, boxwood, and even of horns of different animals, have often been found in these kinds of works; the rude instruments of a people little removed from barbarism. During the time of the Normans great wealth accrued to the Earls of Cornwall from dues and imposts on tin payable to them, and these still continue to be paid to the Dukes of Cornwall, the blocks of tin being *coined* or stamped with the seal of the duchy after the dues have been paid.

In what position are tin ores found?

In veins or fissures called locally *lodes*—their direction is mainly from east to west, and they branch out and divide like the boughs of a tree, diminishing till they terminate in mere threads. Tin is also found in a dispersed form in loose stones, which, when found continuously, are called streams. The most common tin ore is very hard and glass-like.

Are the tin mines now carried on with spirit?

Yes; and often at a great expense, which arises from the galleries having to be supported with large timber. The most remarkable mine in England is one which has long been abandoned on account of its danger; this, the Huel-cok, is carried under the bed of the ocean below low-water mark; and, in one place where the rich vein ran upward, the improvident miners pursued it till only four feet of rock were left between the mine and the bed of the sea, which could be distinctly heard howling and roaring, the rolling of the masses of rock moved by the waves sounding like repeated peals of thunder. Another mine, called the Huel Ferry, is entirely submarine.

How is the tin obtained from the ore?

The rock is blasted with gunpowder, and carried to the stamping-mill, where it is pounded small and washed from the mud with which it is mixed. It is next smelted in large furnaces, culm coal being used as a flux; the tin is run from the furnaces into blocks weighing from two to four hundred weight each.

For what purpose is Tin chiefly used?

Beside the use already mentioned of coating vessels made of other metals to prevent their rusting, which is the principal one, pure tin is used for making dyers' kettles, which are consequently very expensive: and it is made into tin-foil, which is an article of great use—this is made by rolling and hammering tin till it is hardly a thousandth part of an inch in thickness. Tin has also an important place in the art of dyeing; solutions of tin in nitric, muriatic, and sulphuric acids being used to give a degree of permanence and brilliancy to several colors not to be obtained without it.

What is Copper like, and what is it used for?

Copper when pure is of a singularly red color, exceedingly malleable and ductile: it can be hammered when red-hot; it is not so hard as iron, but nearly as tenacious; and is remarkable for not corroding by exposure to the air; immense quantities of it are used in this country for coppering the bottoms of ships, for coinage, and for a multitude of household utensils, &c., as well as for making brass.

Has copper long been worked?

Yes, it appears to have been well known to the nations of antiquity, and often when *brass* is mentioned in old books, *copper* must be understood; as for example, the passage in Deuteronomy, which describes "a land whose stones are iron, and out of whose hills thou mayest dig brass." Copper, both for working by itself and for the manufacture of brass, was early obtained from Egypt, one of the chief sources of the wealth of the Pharaohs being the copper mines of the adjacent countries of Nubia and Ethiopia; copper was known too in Greece, from the earliest settlement of the country. There is a curious collection of Scandinavian antiquities at Copenhagen, in which are many swords, knives, and daggers, the blades of which are made of gold or copper, with an edge of iron; proving, by the parsimony with which the latter metal was used, how much more abundant were the other two.

Where are the principal Copper mines?

The mines which supply the copper of commerce are situated in almost all parts of the world, a large proportion of which are worked by English companies, and made tributary to the great smelting establishment in South Wales. Copper mines are worked on the range of the Andes, the Cordilleras of Central America, and the Appalachians of North America, the geological formations of these mountains being productive of copper ore. In the Eastern and Middle, Southern and Western states, copper mines exist, the most famous of which are those of Lake Superior.

What are Copper Mines like?

All that is visible on the surface is usually several buildings, more or less rude in structure, containing the engine, the steam-pump, &c., and a number of sheds where the copper ore is stowed as it is brought to the surface, and picked over by women and girls, who, with a little mallet knock off the unproductive pieces, leaving only such as will pay the expense of working it; all that they throw out is carried away in barrows, and added to the heap of refuse, which in time becomes one of the most conspicuous features of the mine, when seen from a distance. Another characteristic, too, is the mountain stream, which, instead of running clear and pure as before it reaches the mine, flows on thick and black, or dingy gray, and so charged with metallic matter as to be any thing but fertilizing in its progress. There is a curious copper mine in Cornwall, only a few miles from the Land's End, which is called the Botallack Mine. Approaching it, you see the various buildings and machinery connected with the mine, not grouped together on the level ground or hill-side, as is usual, but scattered up and down the precipitous face of the cliff, on all the available ledges of rock, where there would appear to inexperienced eyes to be only space enough for a gull's nest, the sea breaking and roaring at the bottom. This mine, which is worked to a very great depth, is carried out several hundred yards from the shore, below the bottom of the sea; and as you traverse its narrow and dark passages, you may hear the low moaning of the ocean far above your head; when the weather is rough, and the sea runs high, this dim, mysterious sound is increased into a roar, fierce and awful beyond all imagination; and such is the horror of the miners, that though so long accustomed to the spot, they seldom continue working when a storm occurs, but find their way back to the upper air. The galleries of this mine are very damp, the salt water from above forcing its way through numerous crevices too minute to be seen, and dripping slowly on the floor.

Is Copper ever found pure?

Sometimes, in small quantities; and veins of copper are not unfrequently visible in cliffs laid bare by the sea. It is remarkable that, while there are hardly more than four or five different sorts of tin ores, and only one at all common, those of *copper* are almost innumerable; in one collection in Cornwall a thousand varieties are shown. One poor ore, the green carbonate of copper, is now become familiar to the world as the beautiful green stone called *malachite;* which is used for ornamental purposes. The richness of the ores varies very much, and consequently their value. A large quantity of the Cornish copper ore is conveyed to South Wales to be smelted there, because of the abundant supply of fuel which the Welsh coal-mines afford; the vessels which convey the copper ore, load back with coal to feed the mining steam-engines.

What is needful to be done to obtain pure Copper from the ore?

The different ores are well mixed, this being desirable, as one ore often acts as a flux to others; the whole is then calcined, remaining twelve hours in the furnace, from which it is raked out black and powdery. The next process is smelting, during which the slags, or earthy parts, rise to the surface and are cleared off, the metal being run out into pits filled with water, which causes it to become granulated. These two processes are repeated twice more, and then the metal is roasted again; which oxidizes the iron and other metals still combined with the copper. Nothing now remains to be done but refining and toughening; the latter is a curious process: the metal in the furnace is covered with charcoal, and a pole of birch-wood is stirred in it, this causes ebullition, and the grain gradually becomes finer, the color a lighter red, and the metal more malleable.

Now you have told me about Iron, Tin, and Copper, will you tell me where Lead comes from?

The principal lead mines of England are situated in the Mendip Hills in Somersetshire, about Hexham in Northumberland, and in the High Peak in Derbyshire; many of the remarkable caverns shown in this latter district, are extinct lead mines; and the whole surrounding country was known by the name of the King's Field, from the number of mines, all of which paid a consideration to the king. Lead generally occurs in limestone; the process of reducing the ore to pure lead is much the same as that employed for tin; stamping, washing, and smelting; only the lead usually passes out of the miners' hands before the smelting, which is performed by the owners of cupolas or smelting-houses.

Could you describe this process of Smelting?

The ore supplied to one charge of the furnace should consist of from five to eight different sorts, on which mixture the perfection of the article much depends. This charge is first roasted, to dissipate the sulphur and arsenic contained in the ore, and then fused, in which state it is covered with a stratum of slag or refuse, swimming on the top of it to the depth of two or three inches; the slag is first drawn off, and afterward the molten lead is allowed to run into a pan provided for the purpose, where it is skimmed and ladled into moulds.

Is this Slag of any use?

It is remelted, and the lead produced from it is much harder and more sonorous than furnace lead, and is preferred for various purposes. The ore of lead is very poisonous, and the fumes arising from its preparation have a very injurious effect on life, both animal and vegetable.

For what purpose is Lead chiefly used?

By far the greater quantity of lead used in this country, is used by the plumber in the state of sheets; these are either cast on flat tables (cast-lead), or rolled out between large iron rollers (milled-lead); these sheets are used for roofing, making pipes, cisterns, tanks, and for leaden coffins; its remarkably tenacious and non-elastic character rendering it for many uses invaluable. It is not with us that the use of lead is confined; its wide diffusion and the ease with which it can be worked, cause it to be much employed in all countries which have arrived at any degree of civilization; among others the Chinese use large quantities, and they have a very ingenious method for making the thin sheets in which they pack their tea for exportation: one workman sits on the floor with a large flat stone before him and another stone at his side; a second workman stands by with a pot of melted lead, and pours a little on the stone, when the first suddenly places the movable stone on the melted mass; and squeezes it out into a flat thin sheet, which is afterward trimmed; the process is very expeditious and effectual.

Are not Bullets and Shot made of Lead?

Yes; the former are cast in brass moulds—the latter is made in the following curious manner: the towers where shot is made are mostly about one hundred and fifty feet high, and at the top is a furnace-room, where pigs of an alloy of lead and arsenic, which have been hoisted up by machinery, are melted; and then the metal is poured into a sort of colander, the size of the holes in which regulates the size of the shot; through this colander it drips rapidly in little globules, which, cooling as they descend, are received below in a large vessel of water. The shot is afterward sifted, and the imperfect shot separated by an ingenious contrivance; a measure of shot is poured out on a wooden tray suspended from the ceiling; a boy, who attends to two trays at a time, gives them a sideway motion, when the perfectly globular shot run off immediately to the lower end of the tray, and thence into a bin below; while the imperfect ones remain behind, and are thrown into another bin to be remelted.

Was Lead known to the ancients?

Yes; we have abundant testimony that it was known very early, and it is mentioned in the book of Job—"Oh that my words were graven with an iron pen and *lead* in the rock for ever!" Nor does there appear any reason to doubt that the metal meant is the lead with which we are acquainted. It is remarkable that many ores of lead contain much silver; and there is no doubt that, in former times, this alloy was often used without any attempt being made to refine the more precious metal from it. You will see by what I have told you about lead that it is one of the softest, heaviest, and most widely known of the metals; except when newly melted, it is of a dull bluish color; it does not melt so readily as tin, but it is so malleable that it can be hammered or rolled into sheets with the greatest ease, and a single blow is sufficient to indent a solid lump. It is hardly elastic at all.

What is Black-Lead, of which pencils are made?

It is not lead at all, though formerly considered so. More recently it was supposed to be a carburet of iron; but later experiments appear to have proved that it is only a peculiar form of carbon. Its proper name is Plumbago, or *Graphite.*

From whence is Plumbago obtained?

The finest quality of this mineral which has ever been discovered is obtained from a mine at Borrowdale, in Cumberland, England; but it is found in various parts of the world; and an inferior quality has been of late years imported from Mexico and Ceylon in considerable quantities, which is used principally for making crucibles or melting-pots, for diminishing the friction of machinery, and for protecting iron from rusting—the finer qualities suited for pencils being too valuable for these uses.

Is it found in veins, or as an ore combined with other substances?

Neither; it is sometimes found crystallized, but more generally in detached masses or nodules, some of which weigh four or five pounds each. At Borrowdale "nests" of these are formed in a greenstone rock, which constitutes a bed in the clay slate. This peculiarity is the cause of its being often "lost," when the miners have to seek at random for a new supply.

Are the Cumberland mines very old?

Their age cannot be exactly ascertained, but they have been occasionally worked ever since the reign of Queen Elizabeth: they are private property. There are traditions of the time when the value of this curious mineral was so little understood, that the shepherds used it in large quantities for marking their sheep. After this time came one in which the proprietors made enormous profits, and the quality of the mineral was so good that a workman could in half an hour obtain as much as would sell for £1,000. It was the practice at this period to open the mines only occasionally, thus reducing the supply and raising the price; the modern importations from abroad have very much lessened the monopoly which enabled the proprietors to do this. Formerly so great was the fear lest any of the precious material should be stolen, that houses were built at the entrances to the mine, in which the workmen were obliged to change their clothes, and were all searched before leaving their work to see that they had none secreted about them. The finest plumbago was also taken from the mine to Kendal under a strong guard, and from thence conveyed to London by persons who were held responsible for its safe delivery.

What is Zinc?

A metal which has been comparatively lately discovered in its pure form, though one of its ores, calamine stone, has long been known and used. It abounds in China, and the Chinese were the first to use it; they also exported it in large quantities to India, whence much was imported to England, until it was discovered that they possessed ores of it themselves. The largest proportion of zinc, or spelter, as it is frequently called in its metallic form, is obtained from the German states, who not merely supply the home markets, but have superseded the Chinese in the trade in India. Zinc is a hard, bluish white metal, not malleable when cold, breaking readily under the hammer, and showing particularly brilliant crystalline fracture; but at a moderately high temperature it possesses great malleability and ductility, can easily be drawn into wire and rolled into plates, and worked in other ways. Zinc is well suited for casting figures; it melts readily, liquifies completely, and therefore copies every line of the mould more accurately than harder metals. A cast can be made in zinc for one-sixth or one-eighth the cost of bronze, and can afterward be bronzed so as to look almost as well as that metal. Zinc plates are used for many purposes, and in roofing they are valuable for their lightness, being about one-sixth part the weight of lead ones; they are not liable to rust or corrode from exposure to the air; many vessels are now made of zinc, and for galvanic apparatus this metal is used.

You have not yet mentioned Brass; where is that metal found?

Brass is not found in any mine as the metals we have been speaking of are; it is a compound metal, or, as it is properly called, an *alloy* of copper and zinc; it was well known in the earlier stages of the arts, long before pure zinc was discovered, being made of copper and calamine stone, which is an ore of zinc. The manufacture of brass is said to have been introduced into England in 1640, by a German who settled at Esher in Surrey. Good brass is of a fine yellow color, ductile and very malleable when cold; when heated it is brittle; being in this respect a curious contrast to the zinc of which it is partially composed. Brass is the most convenient metal for making large fine screws, astronomical instruments, microscopes, and many other things requiring great exactness; as, notwithstanding its compactness of texture, it is easily wrought at the lathe.

How is brass made?

The copper intended to be used is poured hot into water, which makes it into little grains, or what is called *shot-copper*; this is done to increase its surface. The calamine stone (carbonate of zinc) is heated red-hot, ground to powder, and washed; the ingredients are then fused together in the proportions of about forty-five pounds of copper to sixty pounds of calamine stone; an equal bulk of charcoal, and some scrap brass are usually added. The melted brass is cast into plates or bars; the plates are rolled into sheets, called latten; or beaten into thin leaves, called Dutch gold, and used for inferior gilding. The bars are used by those who make small brass wares, or who melt it again with different proportions of copper, to make tombac, pinchbeck, and other imitations of gold.

What are these imitations used for?

To make a great many small articles, such as brooches and all sorts of jewelry, which are very cheap and smart;

in former times, watch-cases were frequently made of these metals, but it is not quite so common now.

Pins are made of brass wire, and are tinned afterward; the wire is cut into pieces the length of six pins, and the points of a handful are ground at once, a pin's length is then cut off, and the points ground again, and so on, until the wire is all used, and six pins have been made of each piece; the heads used to be a little ball, made with fine wire spun with a wheel, and then fastened on to the pin with a smart blow; but now they are made solid, the top of the wire being pressed in a die to form the head, which prevents its coming off; pins are polished by rubbing them in dry bran.

What is the white metal of which this teapot is made? It is not silver I know, and lead would be too soft, is it tin?

No; it is a mixed metal called Britannia metal, and is composed of block tin, a small portion of antimony, and less than one-third as much copper or brass. This compound, which is bright and silvery-looking, is now extensively used instead of pewter, and for many purposes to which pewter was never applied. It is very easy to work, both by rolling, casting, turning, and planing, as well as by stamping in dies; consequently, the articles made of it are almost unlimited in variety, and very cheaply produced; teapots, candlesticks, and spoons are among some of the most frequent applications of this metal.

What is Pewter?

Pewter is a dull-looking alloy, used for making plates and dishes, beer measures, wine measures, and larger vessels. For the first purpose it is very much gone out of use, being superseded by earthenware; but in former times all houses were supplied with pewter articles, and no small portion of the "plate," belonging to the wealthy, was of this material. Good hard pewter is made of tin, copper, and antimony; but a very inferior kind, and that most frequently met with, is made chiefly of lead, with a very small proportion of tin and copper in addition.

Are there any other alloys of Copper in common use?

Yes; bell-metal, gun-metal, and bronze, are all formed chiefly of copper with the addition of tin, and in some cases small quantities of other metals.

Are all the metals solid bodies?

There is only one which is not, and this one becomes so when cooled to forty degrees below zero; you know this strange metal well by sight, it is the one used in barometers and thermometers to show the changes in the atmosphere; it is called *Quicksilver*, or *Mercury*. It is white, rather bluer than silver, and as it is from its great fusibility habitually fluid, it readily unites with many other metals and imparts to them a degree of its characteristic quality; when these metallic mixtures contain sufficient mercury to render them semifluid at a mean temperature they are called *amalgams*.

Of what use is Mercury?

You have already heard that it is used for making barometers and thermometers; it is likewise employed for silvering looking glasses and for gilding, in which latter process the gold and mercury are laid on together in the form of an amalgam, and the mercury afterward dissipated by the action of heat. It is also employed in the preparation of several powerful medicines, and in the manufacture of vermillion. But by far the largest quantity of mercury is used for amalgamation with native gold and silver to facilitate the extraction of the pure metal.

Where do we obtain Mercury?

The chief mines of mercury, or quicksilver, are in Spain, in the provinces of Asturias and Andalusia; there are mines too at Idria, in Carniola, which are very productive, and others in Tuscany and California. Mercury is found both native and mixed with sulphur, in which state it forms the red ore called cinnabar.

Which are the Precious Metals?

Gold and silver, the metallic substances first known to mankind, and from the first held in great estimation; the earliest mention on record of gold is in Genesis, where it says, of the land of Havilah, "There is *gold*, and the gold of that land is good." In the time of Abraham it already passed as money by weight; and was used for making ornaments; nor are there lacking proofs that it was manufactured into many household articles. The abundance of gold in ancient times is very remarkable; for example, the treasures of Solomon, when he made so many things of pure gold; "none of them were of silver for that was nothing accounted of in the days of Solomon," for "the king made silver to be as stones in Jerusalem." Nor does this appear to have been by any means a solitary instance; profane authors speak of the large accumulations of treasure, both by sovereigns and private individuals.

In what state is Gold found?

Not in ores, like other metals, but in a pure or native state; it exhibits many diversities of appearance, being found massive, in scattered particles, in fibres or strings, reticulated or net-like, arborescent, tree-like, and also crystallized. Gold found in rocks is mingled with many different earthy fossils, and often with ores of other metals, and large quantities have always been found in the beds of rivers; which latter circumstance, joined with its beauty, comparative purity, and consequent easy reduction, may account for its always having been the first metal to attract the barbarous tribes.

In what countries is Gold found?

It has been found in some part of every quarter of the globe as before stated; it was first found in the east, and there are still mines in India, Japan, the Philippines, Sumatra, and Borneo, to which may be added Siberia. Gold has been found also in Africa, in such large quantities in one part that it has attained the name of the Gold Coast; Europe, too, possesses a little; there are, or more correctly there *were*, mines in many countries, and even in England; but all these sources were thrown into the shade when the discovery of America laid the treasures of Brazil, Choco, Chili, and Mexico open to the enterprise and cupidity of the Europeans; and in our own days we have seen these again superseded by the discovery of a new El Dorado, in California, and still more recently in Australia; from which two fields our present supply of gold is almost exclusively obtained.

How is Gold prepared for use?

In consequence of the pure state in which gold is found, gold mines can hardly be said to exist, in the sense in which mines are generally understood; they are usually mere surface works, even though in some cases pits are sunk of the depth of many feet; neither is any smelting required, as in the inferior metals, but refining is necessary, to effect which it is submitted to the process of cupellation and parting, in the first of which it yields up every particle of lead or other common metal, and in the second is separated from any silver with which it may be alloyed.

How is Cupellation performed?

The cupel is a small cup composed of calcined bones, or some similar material, slightly moistened and compressed, which has the curious property of not only resisting the fire but of *absorbing* metallic bodies, when changed by heat into fluid scoria, while it *retains* them in their metallic form. The gold is put into the cupel in little buttons, and when fused a scum of lead and other metals rises, which running to the sides of the vessel is absorbed.

What is meant by "parting?"

Silver being nearly as difficult of oxidization as gold, cupellation would not avail to separate it, recourse therefore is had to another process: the gold is rolled out into thin plates, which are cut up and digested in hot diluted nitric acid, this dissolves the silver, and leaves the gold an undissolved porous mass. Gold is the most fixed and incorruptible of all bodies.

Where is Silver found?

It is much more widely spread than gold, and differs from it as to the climates where it is found; gold may be called *tropical* in its habitat, whilst silver abounds most in high latitudes, or at great altitudes. The most celebrated mines of Europe are in Norway and Sweden, and those of Mexico and Peru are in the centre of the chain of the Andes, in the most cheerless regions of perpetual snow; there are mines also in the north of Asia, but none have yet been discovered in Africa. The most productive mines in the world are those of South America.

Is silver ever found in ores?

Yes; in this it differs from gold, for though it is sometimes found pure, it also occurs in various ores; some more and some less frequently met with. One rather remarkable state in which it is found is in amalgamation with mercury, and semifluid. Native, or, as it is sometimes called, virgin silver, is not only met with in masses, but in large patches, beautifully branching out from the central deposit, or sometimes extending into an entangled net. Herrera, the Spanish historian, attributes the discovery of the silver mines of Potosi in Peru to the fact of an Indian hunter having pulled up a shrub, and found its roots entwined with filaments of pure silver, which turned out to be ramifications from an enormous mass of the metal. Silver is frequently met with in lead ore.

How is silver extracted from its ores?

Either by the ordinary process of smelting, or by amalgamation; this latter process is carried on in South America, and also largely in Saxony, the chief advantage being the saving of fuel. When the ore contains much sulphur, etc., it is necessary to separate it from these before applying the mercury; this is effected by putting it into a furnace with ten per cent. of common salt, which decomposes the ore; on being cooled, it is reduced to an impalpable powder, and is then ready for amalgamation, which is effected in revolving barrels. The charge in each barrel consists of ore, mercury, iron, and water; the barrels are made to revolve for sixteen or eighteen hours, during which time the silver is set free, by the chemical action of the iron, from the combination in which it was held, and then unites with the mercury; whilst the sulphate of soda and other soluble matters resulting from the addition of the salt are dissolved by the water. The amalgam is then filtered, and heat being applied, the mercury flies off, and the silver remains. It is afterward subjected to cupellation, like gold.

Are the precious metals used pure?

Very seldom; pure gold would not be hard enough to stand any amount of wear; it is therefore alloyed, even for the gold coinage, with a small portion of either copper or silver, and for trinkets and other small wares the proportion of alloy is often much greater. Gold vessels and large ornaments are generally of great value; this is enhanced by their being so frequently made from models which are destroyed in the process, and therefore each is unique. A considerable quantity of gold is employed for gilding, for which purpose it is generally used in the form of gold-leaf.

How is this leaf made?

A number of small thin plates of gold, about an inch square, are laid, two together, between pieces of vellum about four times that size, and with twenty thicknesses of the latter on the outside, the whole being enclosed in a parchment envelope; it is then beaten on a block of marble with a heavy hammer, till the gold is spread out to the size of the vellum; the pieces of gold are taken out, cut into four, and replaced with a prepared animal membrane between each, afterward known as goldbeaters' skin; the beating and cutting is repeated several times more, and, when the gold is thin enough, it is trimmed up and carefully placed in little books for sale. Gold being by far the most malleable metal, is capable, when pure, of being beaten into leaves so thin that two hundred and eighty-two thousand would be only one inch in thickness. In this state it is translucent, transmitting light of a beautiful green color.

Is not silver harder than gold?

Yes; considerably; but it, too, is alloyed with copper for coinage. Large quantities of silver are used for making *plate;* by which term we understand spoons, forks, teapots, salvers, castors, inkstands, and a great variety of other articles, either useful or ornamental, or both; these may be either of solid silver, or, as is very common, of copper or steel plated, or covered over, with the more precious metal.

How is this plating performed?

The common method of plating on copper is the following; an ingot of copper being cast, is filed square and smooth, and a piece of silver is placed upon it; the two surfaces being perfectly clean, a little borax is introduced between the two metals, they are bound together with iron wire, and then heated in a furnace nearly to the melting-point; the small quantity of borax acts as a flux, and thus they are fused together. When this is effected, the metals are rolled out as thin as required, and this sheet forms the basis of every article of whatever shape or form, and however it is to be ornamented when finished; to produce ornaments, leaf silver is stamped in iron dies representing the ornaments required, which, when removed from the dies, is filled with an alloy of lead and tin.

Is this what is meant by electro-plating, of which I sometimes hear?

No; electro-plating is a new discovery, and has very much superseded the process we have just described, at least for the better kinds of plated goods. In electro-plating pure silver is precipitated, by the action of a galvanic battery, from a solution in which it is held, on to the articles after they are formed; this process possesses many advantages; among the rest may be mentioned, that, instead of copper, a hard white metal can be used, which wears much better; the electro-plating also renders the application of embossed borderings and ornaments more easy, and they are more capable?

Are there any other precious metals?

The only one which has any claim to be ranked among them is platinum, which resembles them in many of its qualities; being indestructible as gold, hard as iron, in color resembling silver, and extremely ductile and tenacious. Gold has been drawn into wire of which 550 feet only weighed a grain, and which is 1-5000th of an inch in diameter, but platinum has been made into a wire of only one-sixth of this diameter. Platinum is a metal but recently discovered, not having been known earlier than the eighteenth century. The principal supply comes from South America, but Russia draws large quantities of it from mines in the Ural mountains. There was a coinage of platinum money in Russia, but it is now called in.

Are there any other Metals?

Yes; the ancients are supposed only to have known the seven principal ones: gold, silver, copper, iron, lead, tin, and mercury; none were added to the list in the dark ages, but in the fifteenth and sixteenth centuries, zinc, antimony, and bismuth were discovered; in the eighteenth, platinum, nickel, arsenic, cobalt, and manganese, with seven or eight others; and in the present century, some twenty more.

Are these new metals employed in the arts?

Antimony, which is very hard, is used as an alloy with tin and lead for various purposes where great hardness and durability are needed; thus *type-metal,* of which are made the little letters which must be firm enough to bear the pressure of the heavy printing-press, and yet retain all their delicate lines sharp and clear, is composed of lead and antimony. This metal is also used in medicine, and its oxide in coloring glass.

Bismuth is chiefly remarkable on account of its extreme fusibility; to exhibit which quality, spoons are sometimes made of it, which, when put into boiling water, or even very hot tea, melt and lose their form. It is used as a flux, and with the addition of tin, lead, or copper, it makes solder.

Nickel is a hard white metal, more nearly resembling silver than tin does; it is chiefly brought from Germany to this country, and is much used in the manufacture of German silver. It is not, however, abundant, which remark applies to all these new metals, cobalt excepted.

Arsenic is used in many metallic alloys, its various oxides are ingredients in different dyes; it is used as a flux for glass, and to produce some kinds of coloring in glass. It is likewise put into some composite candles; and, though a virulent poison in all its forms, is employed as a medicine; the arsenic of commerce is a white oxide of the metal.

Cobalt, though rarely used in the metallic form, is invaluable for the beautiful blue pigment which its oxides afford, and which is the only blue color employed in the manufacture of china and glass—the color known as Smalt, is glass colored with cobalt, and ground to an impalpable powder. One grain of cobalt will give a full blue to two hundred and forty grains of glass.

The black oxide of manganese, which is the most common form in which this metal is found, is very useful in many chemical preparations; and is employed to give a violet color to china and glass, and used by glass-makers to bleach out the greenish or yellowish hue glass is sometimes inclined to have.

I had no idea these substances were metals, are there any more which are useful?

Yes; there are many more, but it would not interest you to hear about them all. The beautiful color known as chrome yellow is obtained from a brittle white metal, first discovered in Siberia, called *Chromium;* and *Cadmium*, another of these metals, yields another yellow pigment. Then there are *Rhodium* and *Iridium*, which have become known at least by name, from being applied to making points to the gold pens now so much in use: they are well suited for this purpose, being hard and not easily affected by the acids contained in the ink. Medals have been struck in *Palladium*, a white metal resembling silver; but the most remarkable of these recently discovered metals is *Aluminum*, which resembles silver, though easily distinguished from it by its greater whiteness; it is also much lighter. The ore of this metal is pure clay, a substance with which man has been familiar for ages without suspecting the treasure it contained; and so large a proportion of the pure metal does it contain, that the richest iron ore is said to be poor in comparison. At present, some practical difficulties in the way of cheaply reducing it, joined to its novelty, contribute to make it scarce; but when we consider how widely scattered over the face of the globe, and how abundant clay is, we cannot doubt that in time *Aluminum* will take its place among the useful metals and even supersede some of the older ones.

What is Bronze?

A compound of copper and tin, which metals appear to possess the quality of hardening by combination. Bronze, which is the result of this combination, was known at a very early period; it was extensively used by the ancients for arms, medals, and works of art. The ancients considered this metal as naturally pure; all their instruments of sacrifice and sacred vessels were, therefore, of bronze. It was sacred to the gods; the emperors could not strike coins of bronze without the permission of the Senate. The moderns have also made much use of bronze, especially in vases, statuettes, and other works of art; and also for casts of celebrated antiques. In casts, the moulds are made as the pattern, of plaster and brick-dust. The parts are then covered on the inside with a coating of clay as thick as the bronze is intended to be. The mould is now closed, and filled on its inside with a nucleus, or core, of plaster and brick-dust, mixed with water. When this is done, the mould is opened, and the clay carefully removed. The mould with its core are then thoroughly dried, and the core secured in its position by bars of bronze, which pass into it through the external part of the mould. The whole is then bound with iron hoops, and the melted bronze is poured in through an aperture left for that purpose; of course the bronze fills the same cavity which was occupied by the clay, and forms a metallic covering to the core. Bronze casting was known at an early period; it reached its perfection in Greece about the time of Alexander the Great. The green hue that distinguishes ancient bronzes is acquired by oxidation and the combination with carbonic acid; and the moderns, to imitate this effect, sometimes give an artificial tint to the surface by washing it with an acid. What is called *bronzing* is an attempt to produce the effect of bronze on other metals or substances. A solution of sal-ammoniac and salt of sorrel in vinegar is used for metals; for wood, plaster figures, etc., a composition of yellow ochre, Prussian-blue, and lamp-black, dissolved in glue-water.

About Leather.

What is Leather?

The skins of various kinds of animals prepared by tanning and dressing.

What is meant by Tanning?

The conversion of skins into leather by the chemical combination of the skin with an astringent vegetable principle called *tannin*. Skins simply dried are pervious to water, soon become worn with friction, and quickly putrefy when moistened. All these evils may be remedied by taking advantage of the property which skin, in common with other animal tissues, possesses of forming a true chemical combination with tannin; and a piece of prepared skin, saturated with this astringent principle, becomes hard, insoluble in and almost impervious to water, and incapable of putrefaction.

What material is used for Tanning?

Oak bark is used in the largest quantity; it is stripped off the trees when they are cut down in winter or spring, and piled up in little stacks to dry.

Is oak bark the only substance which possesses the power of tanning leather?

No; other substances also contain the tannin, and are sometimes used for this purpose; the chief of these are gall-nuts; *valonia*, or the acorn-cups of a species of oak growing in Asia Minor and the Morea; catechu, or *Terra Japonica*, which is the inspissated juice of the *Acacia catechu*, and the *Uncaria Gambir*, both natives of India; *Divi-divi*, which is the pod of a leguminous shrub growing in South America; sumach, that is, the leaves of *Rhus coraria*, a shrub which grows in the south of Europe; cork-tree bark, not the substance known as cork, but vital inner bark; larch, birch, and willow bark. The effect may be produced in a less degree by impregnating the skin with a solution of alum; also with oil or grease.

How are the skins prepared for Tanning.

The skins and hides (as those of larger animals are called) are first prepared by washing, and soaking in lime-water, to loosen the hair and outer membrane; for all skins consist of two parts—the cutis, or true skin, which is a delicate tissue of fibres crossing each other in all directions, and full of little conical pores; and the cuticle or outer coating, which is an insensible horny membrane; this latter is removed, that the tan may be absorbed on both sides of the leather. After they are sufficiently limed, the skins are stretched singly on an arched wooden or stone bench, one end of which is considerably raised; with a two-handled iron scraper, the hair and cuticle are then removed, and the skins are slightly scraped on the inner side as well. Those intended for soft, pliant leathers are soaked in an alkali, after the liming, in order to withdraw all the lime, which would make them hard and stiff.

How is the Tanning effected?

The hides are first soaked in a diluted acid, which swells them and opens their pores to receive the infusion of tan more rapidly; they are then piled in pits with ground tan between each skin, the pit being afterward filled with water; the pits are emptied and the hides replaced with fresh bark and water about every two or three months; the time required for tanning a hide of ordinary thickness by this means is two years.

What a long time for the skins to be tanning; is there no quicker mode?

Yes; there have been sundry contrivances by which the time required for the process has been very considerably shortened. A strong solution of tan is used, and sometimes it is applied warm. The point to be obtained is to get the tannin into all the minutest pores of the skin, and this has been attempted by exhausting the air, and forcing the liquid in by high pressure; but the effect has been to distend the pores, and to diminish the wet-resisting quality of the leather. Thus none of the modern processes can be considered improvements on the old slow and tedious mode; for what is gained in time is lost in quality.

Are all kinds of light and fancy Leathers prepared in this same manner?

There are three different classes of light fancy leathers: those prepared by tanning with sumach, tawed leather, and oiled leather. The first is chiefly applied to making morocco, the process being carried on in pretty much the same manner as ordinary tanning, only the skins are sewed up into bags and filled with the decoction of sumach. The skins are next dyed and afterward softened, which is done by rolling them between cylinders, or rubbing them with hard balls, one of which has on its surface a number of fine parallel grooves, which impart to morocco the grain peculiar to it.

What is meant by Tawing?

Dressing, after the manner of tanning, with a solution of alum and common salt mixed with flour and yolks of eggs, this makes the skins very supple, and is the mode most employed for dressing kid, lamb, and other leathers intended for gloves; tawing makes the leather white. The preparation with oil alone is applied to those kinds called chamois and wash-leather; the skins are cleaned and prepared, steeped in fermenting bran-water, and then beaten till dry; they are next saturated with oil and beaten all the time, afterward slightly fermented, and lastly rinsed in a weak solution of potash to remove the superfluous oil.

What is Currying?

Currying is the general name given to the various operations of dressing leather after the tanning is completed, by which the required smoothness, lustre, color, and suppleness are imparted. They include beating upon a trellis-work of wooden spars; the scraping, cleaning, and shaving down to an equal thickness; rubbing the grain or hair side with pumice-stone; rubbing it with the *pommel*, a rectangular piece of hard wood, polishing the surface with smooth wood or glass; and when designed for the shoemaker, applying to it a greasy composition called *dubbing* or *stuffing*.

What is Russia Leather?

A variety of fancy leather made by tanning the skins of oxen, calves, sheep and goats, with a warm decoction of willow bark; dying them reddish with red sanders-wood; and afterward applying, by a sort of currying process, an empyreümatic oil, prepared by distilling birch-bark, which imparts to this leather its peculiar and agreeable odor. This odor renders Russia leather repulsive to insects, and thus makes it useful in preserving articles from their ravages.

What is Patent Leather?

A leather covered with a coat of elastic japan, which gives a surface like polished glass, impermeable to water; and hides prepared in a more perfectly elastic mode of japanning, are called "enamelled leather."

What is the process of Japanning?

Japanning is the art of producing a highly varnished surface on wood, metal, or other hard substances, sometimes of one color only, but more commonly figured and ornamented. The process received its name from Japan, whence articles so varnished first came. In the application of the process to leather, the material is first stretched on frames or boards, and brushed over two or three times with seed-lac varnish to form the priming; successive coats of transparent varnish are then added; a hot oven is used to hasten the drying of the work; and when thick enough, the varnish is polished by rubbing it with a rag dipped in finely-powdered tripoli, or rotten-stone. The process is completed by rubbing the surface with oil. When other substances than leather are japanned, and the subject is to exhibit a design, the priming is covered with a varnish previously mixed with a pigment of the tint desired, upon which the objects are painted in colors mixed with varnish, after which coats of varnish are applied, and each coat successively dried by artificial heat.

What is the leather called Shagreen?

A peculiar kind of leather, formerly much used for the covers of watch-cases, mathematical instrument cases, etc. It is produced by soaking, scraping, rubbing, softening, salting, and dyeing. The unevenness of surface is produced in a singular way. The grain side of the skin is strewed with the hard round seeds of the goose foot (*Chenopodium album*), a felt being laid over these, they are trodden deeply into the soft, yielding skin; and when dried, the seeds are shaken out, leaving the skin in a hard state, covered with deep indentations.

About Coal.

What is this Coal, it looks like a stone, and it seems so strange that stones should burn?

Coal is a curious link between the vegetable and the mineral kingdoms; it is really wood and leaves, and other kindred things, which have passed by some mysterious transformation into the hard, black, shining inflammable mineral substance which we burn. This change is one of the most remarkable that Geology records.

What is meant by Geology?

Geology is the science which tells us of what our world is composed, of the granite and the marble, the chalk and the sand; how all these varying substances are arranged in layers, or strata, as they are called, and of the strange and mighty changes which have taken place through countless ages, before the world was fitted for the habitation of man, and of the present races of plants and animals.

Were there, then, different plants and different animals before these?

Yes, these different strata, all but the very earliest ones—the granite and those hard rocks which are thought to have been brought to their present crystalline structure by the power of intense heat from below—abound with the remains of plants and animals; some of them resembling those of our day, but the greater number quite different, and showing that several creations have come and gone. And in some substances, as in that of coal, we can distinctly see the beautiful arrangement by which these earlier creations have been made subservient to man's use.

How was this Coal made?

The process of transformation will perhaps always remain a mystery; to understand it a little we must go back to the time called by geologists the carboniferous period. At this period they tell us the earth presented as now a divided surface of sea and land, though the land had by no means the same form, neither was it in the same position as now. The temperature also must have been much higher than at present; for all along the colder regions of the earth flourished dense forests, *tropical forests*, composed of tree ferns, club mosses, and gigantic trees of the coniferous or cone-bearing tribe; suddenly these grand forests must have been submerged, either by the sea or some adjacent lake, and then covered up with clay or some other stratum, and there, in this air-tight prison, subjected to heat and intense pressure, decomposition went on, while all the gases which would otherwise have been thrown off, were kept in by the superincumbent clay, and thus what has been called bituminous fermentation was produced, by which in the process of long ages, coal was formed.

How can the geologists know all this about the origin of Coal?

In the first place, they judge by the position of the coal; to make you understand this it is needful to describe the successive layers of a coal-field. First, there is a bed of clay abounding in a kind of fossils which have been proved to be the roots of large trees; then comes the *coal*, generally so far carbonized that it shows no external trace of the plants of which it is composed, though when subjected to the microscope, it shows the internal fibre and tissues, which proves it to have been of vegetable origin; on the top of this lies the roof or upper bed, which generally consists of slaty clay, and abounds in leaves, trunks, stems, and fruits, often mingled with fresh-water mussels, or marine shells, and sometimes with layers of sand and pebbles, the remains of drifted materials; which shows that water, either fresh or salt, was the agent by which this vast forest was prostrated and buried.

Are there none of these trees left standing to show how they grew?

Yes; there are several instances in which fragments of trunks, as much as eleven or twelve feet high, have been found with their branched roots imbedded in the lower clay, and their trunks standing up through the bed of coal above; some are fully carbonized, while others have evidently been hollow trees at the time of their being buried, their interior being filled with clay. The most remarkable instance of these trees still standing, which has been hitherto observed, is on the southern shore of the Bay of Fundy, in Nova Scotia; where the cliffs, which are about two hundred feet high, are composed of carboniferous strata, consisting of coal, clay, grit, and shale, in which numerous erect trees are seen on the face of the cliff. There are ten rows, one above another, indicating repeated subsidences of the land, so as to allow of the growth of ten successive forests.

Then this coal-making was not all done at once by some great deluge?

By no means; we sometimes find the three successive layers already described, and which represent the soil, the forest, and the rubbish which buried it, repeated some thirty or forty times one above another, through a thickness of many thousand feet. This involves the belief that the land through successive ages, after the produce of its first forest must have sunk, and then been raised again; another bed of soil fitted to the production of forest trees must have accumulated; another tropical forest must have risen above the old one—flourished, arrived at maturity, and been destroyed like its predecessor, and this must have gone on for ages all over the world at once. Truly it is a grand and awful consideration! a beautiful commentary on the declaration that to the Creator a thousand years are as one day, and one day as a thousand years.

Were there no animals in the times when these forests were growing?

There appear to have been very few living creatures then, and those only of the lower orders; a few insects, a few fish and crustacea are preserved in the drift-bed which covers the coal, but there is no trace of the abundant animal life by which the primeval forests of our own day are tenanted. Instead of the singing and endless chirping of birds, the chattering of monkeys, and the countless noises of woodland animals, the most perfect silence must have reigned, except when broken by the whispering of the trees, or the roar of the hurricane.

Where are the chief Coal-Mines?

America has the largest *coal-fields*, but the largest number of *coal-mines*, properly speaking, are to be found in England. The deposits of coal in the United States are great, embracing nearly the entire area of the country from Maine to Florida, and from the Alleghanies to the Pacific. Upon the slopes of the Alleghanies, by the upheaving of heated mineral masses, the bitumen has been expelled, and the coal converted into anthracite; but as the coal-beds pass westward toward the Mississippi, the quantity of bitumen in the coal equals that found in English sea-coal.

What kind of a place is a Coal-Mine—will you describe one for me?

Imagine yourself in the north of England, near Newcastle, we will say, and that we are going together to see a mine. The first sign of the mouth of the pit will be a few sheds and large heaps of dust-coal, and there we shall see the crane and pulleys hanging over the shaft, which looks like an immensely deep well. We must put on pitmen's dresses before we can descend; then we must step into the iron tub or bucket, which is large enough to hold quite a party at once, and is now swinging to and fro at the top of the shaft—in we step, the chains rattle and away we go down, but we do not feel the motion, only the round hole at the top of the shaft seems to fly away upward—in about four minutes we are at the bottom. Some of these shafts are twelve hundred feet and one sixteen hundred feet in depth. Arrived at the bottom, as soon as our eyes are used to the dim glimmering light of the oil lamps and pit candles, we see a number of passages cut out of the coal, and trains of coal wagons drawn along iron tramways by horses or ponies; the air of the pit seems so well to agree with these animals that they are always fat and sleek, not appearing to suffer as the men and boys do, who are most often thin and pale. We must each take a candle in our hands and march along the main way, which is high enough for us to walk upright; soon we find a heavy door which is placed here for ventilation, for all mines are ventilated by having two shafts, which are called the *up-cast* and *down-cast;* the latter serves to feed the large ventilating furnace with air which it draws down, while the former, at the bottom of which the furnace is usually situated, acts as chimney and carries off the smoke and foul air from the mine. Of course these shafts must be so placed as that the fresh air shall have to pass through all the main passages before it reaches the furnace, and to regulate the currents of air, doors are placed. These doors are kept by little boys called *trappers,* who sit behind the door and pull it open with a cord; these poor little fellows sit all day long alone in the dark. Further on in the mine we come to boys and lads at work who are called *putters;* they push or "put" wagons loaded with tubs of coals along the lesser passages where horses cannot work. Finally, at the end of the workings we shall find the hewers, the men who really cut the coal from its resting-place; and very laborious work it is, for the seam of coal is often hard, and the confined space, and the need of many props to support the roof, prevent the men from easily wielding their short, heavy picks; they not unfrequently have to work sitting or kneeling, or even lying on their backs or sides.

What is the form of a Coal-pit generally?

Some of the older coal-pits are very irregular; but the modern practice is, generally, to excavate them in squares of large area, each square separated from the adjacent ones by solid walls of coal from forty to fifty yards thick. You may readily understand how the coal is worked out by fancying the ground-plan of each compartment like a window, of which the wooden bars represent the galleries cut out, and the glass panes represent the pillars left to support the roof; when the whole is cleared thus far, they begin cutting away alternate pillars, and sometimes clear them all away, substituting wood props to prevent the roof from falling in.

Are there no Coal-Mines in America similar to those you have described?

No; on the Lehigh River, Pennsylvania, there are coal-mines worked like an open quarry on the slope of a mountain, rising nine hundred feet above the river. The coal is sixty feet thick, and surrounds the quarry in black glistening walls, capped by forty feet of yellow sand-stone. The coal is conveyed from the quarry by a self-acting railway for eight miles down a declivity of over a hundred feet to the mile.

Are there several kinds of Coal?

Yes, and there are several other substances which appear very nearly allied to coal, and to have been formed by a similar process. The peat-bogs of Ireland and other countries afford us the means of tracing the process of coal-making in various stages. The wood of the submerged trees in many of these bogs has undergone no change beyond that of being dyed black from an impregnation of iron; it is quite sound and hard, and can be used as timber. Among these preserved trees are found the skeletons of deer and swine, and sometimes the bodies of the aboriginal inhabitants wrapped in skins. The next stage of the process is seen in the brown coal, or *lignite*, as it is called, which is found in considerable quantities in Devonshire, England, and on the Continent; this substance is intermediate in quality between true coal and peat; it is generally softer than coal, easily chipped or split, and burns to a great quantity of white ash, like wood. Jet, that beautiful black substance used for ornaments, is another variety of lignite, very compact and very light.

What is Lignite?

Fossil wood carbonized into a kind of coal, but retaining distinctly its woody texture.

Are there not sometimes very frightful explosions in Coal-Mines?

Yes, there is a noxious gas generated in these mines from the immense quantity of bituminized vegetable matter, which, when mingled with a certain amount of common air, becomes explosive, and, if fire or a candle come in contact with it, the most frightful results ensue; the unfortunate miners who are exposed to such an accident are either suffocated or burnt to death, or blown to pieces by the violence of the explosion, or, in some cases, they die a more lingering death by starvation, when they are imprisoned in some distant part of the mine by a portion of the roof falling in and preventing their return to the shaft. These accidents are not so frequent now as they were formerly, the diminution being chiefly attributable to the invention and use of Sir Humphrey Davy's safety-lamp. This eminent man noticed that the gas termed by the miners "*fire-damp*" would not ignite at a flame to reach which it had to pass through a small tube; and after many experiments he found that enclosing the flame in a covering of wire gauze would answer the same purpose, the small holes in the gauze representing the tube, and preventing the flame from lighting the fire-damp. These lamps are in many mining districts called "Davys," and where they alone are used the danger of explosion hardly exists; but as the light they yield is very dim, the men are often tempted to use open candles. This useful discovery is generally attributed to Sir Humphrey Davy, but has been claimed for several other persons, and among the rest for George Stephenson, the first railway engineer, who began life as a boy in a colliery, and who rose through his genius for mechanics and his indomitable energy and perseverance.

What is Anthracite Coal?

A hard compact variety, of high lustre, differing from bituminous coal in containing little or no bitumen, in consequence of which it burns without a flame. The purer specimens consist wholly of carbon. The products of the English coal-mines are almost exclusively bituminous coal, while those of the United States, especially the extensive coal-fields of Pennsylvania, are anthracite. Anthracite coal is the result of bituminous coal thoroughly deprived of its gases.

What is Bitumen?

Inflammable substances of a strong smell, and of different consistencies, which are found in the earth. There are several varieties, some of which are nearly fluid, as naphtha, and others cohesive, as maltha, elastic bitumen, or caoutchouc, and asphaltum, which latter is so hard that it cannot be scratched with a nail.

What is Cannel Coal?

A dry, highly bituminous coal, of very close texture, and but little lustre. It is obtained in blocks of smooth and perfectly clear surface. It is remarkable for the readiness with which it kindles, being lighted at once in the flame of a lamp, and continuing to burn with a clear yellow flame, without melting and running down. This property renders it well adapted for illumination, and has given it the name of cannel, which is the pronunciation of the word candle in Lancashire, where the name was first applied. This variety is found in Virginia, Ohio, and Kentucky. The well-known Breckenridge coal is a cannel coal of superior quality, from which Breckenridge oil and Breckenridge candles are now extensively manufactured.

What is Coke?

It is an artificial fuel, made by half burning coal in furnaces called coke ovens; by this means all the gas contained in the coal is driven out, and coke consequently burns without any blaze, and with hardly any smoke. You will readily understand by this description, that one of the results of making gas, as already described, is to convert the coal employed into coke. Coke is useful in many of the arts where a clear steady heat is required without smoke, and many steam-engines, as for instance the locomotives which draw our railway trains, are mostly supplied with coke as fuel. Charcoal, which is made by burning wood in close vessels, the combustion being suddenly arrested at a certain point, is another similar substance, and like coke is very light in proportion to its bulk; it is also brittle, and burns with a clear red heat, without smoke or flame. The fumes of charcoal are very dangerous, and if persons are exposed to them for any length of time in a close room, fatal effects are almost sure to result; there is more need of care on this account, from the fact that these fumes have no disagreeable smell, and only produce gradual sleepiness and faintness, which ends in suffocation. Charcoal is one of the most powerful antiseptics, by which is meant any substance which prevents the commencement or stops the progress of putrefaction. From charcoal is derived *Lampblack*, which is charcoal in a state of minute division. It is prepared from pieces of fir-wood, which are burned in chambers hung with old sacking, upon which the soot collects, and is from time to time scraped off.

What are the uses of charcoal?

Its uses are innumerable. It is used as a fuel in various arts where heat without smoke is required; by cementation with it iron is converted into steel; it is a constituent in the manufacture of gunpowder; it is the basis of black paint, and it is used in the composition of printing-ink; it removes offensive odors, arrests putrefaction, and serves many other important purposes.

As a smell-remover or *deodorizer*, charcoal is most efficacious; its remarkable porosity, and a special affinity it possesses for certain strong-smelling and coloring substances, enables it to absorb gaseous substances in large quantity, and condense them in its pores. So powerful is its operation, says Prof. Johnston, "that if a tablespoonful of finely powdered animal charcoal—or twice as much of wood charcoal—be shaken up with a pint of standing ditch-water, and the mixture filtered, the water will pass through light, clear, and with little either of taste or smell. If instead of dirty water, we take porter, or port wine, smell, taste, and color will in like manner disappear."

About Medicines, etc.

What are Camomile Flowers?

They are the dried blossoms of the *Anthemis nobilis*, a plant found in dry pastures. The cultivated plant is, however preferred; the flowers are gathered before they are fully blown and are dried for use. From their tonic properties they were formerly much used in fevers, and they have been quaintly termed the *cinchona* of the ancients. Medical men derive many of their most useful medicines from plants. In some cases it is the bark of a tree; in others a root, a gum, or an oil; whilst in others the whole plant is made into an extract, or otherwise so treated that its medicinal virtue is drawn out in a concentrated form. Many other common plants, beside the camomile, afford useful medicines.

Will you tell me some of them?

There is the *Tussilago farfara*, or common coltsfoot, a plant so often seen by the side of our railways, where the soil is clayey. This plant is one of those whose flowers appear first, and are succeeded by leaves when the season is more advanced. These leaves, which are large and thick, are boiled down until a strong decoction is obtained. Another is the *Conium maculatum*, or hemlock, the plant with which Socrates was required by his ungrateful countrymen to commit suicide. It is an umbelliferous plant resembling sheep's parsley, but distinguished from it by its spotted stem, from which the specific name is derived; it is abundant in many parts of the country. The next plant I am going to mention is one of very different growth, the *Hyoscyamus niger*, or black henbane: it has a deeply-cut leaf, soft, hairy, and of a bluish-green color; the flowers, which are pale buff, grow in spikes; they have a dark eye, and are beautifully pencilled with dark veins—the scent of the plant is strong and disagreeable. Hemlock and henbane plants are chopped, crushed, and boiled down into extracts of narcotic property.

Is not Deadly Nightshade also a narcotic?

Yes, and also a violent poison, as many poor children, when they have eaten its berries, supposing them to be some pleasant wild fruit, have died; its name is *Atropa belladonna;* it is a shrubby plant, from two to three feet in height; its leaves are a dull green, and it has a bell-shaped flower of a dusky purple hue, and bears a berry which is black when ripe; the plant is prepared for use in the same manner as the two last mentioned. In addition to the foregoing the common lettuce, and a poisonous species, the *Lactuca virosa*, are also in some degree narcotic.

Are not some other plants useful as medicines?

The root of the common dandelion, *Leontodon taraxacum*, yields a medicinal extract; this plant is allied to the chiccory with which coffee is adulterated. Liquorice is also used as a drug, but may be more properly classed with sweetmeats; it is an extract prepared from the roots of the *Glycyrrhiza glabra*, a leguminous or pod-bearing plant, resembling the lucerne with which horses are fed.

Can you give any description of the cultivation of Liquorice?

Small pieces of the root are planted very deeply in rows in a rich light soil; at the end of three years the roots are fit for use; liquorice is grown extensively near Pontefract, England, and close to its ancient and ruined castle; whose portcullis is still stamped on that preparation of it known as "Pomfret Cakes." Liquorice is largely imported from Spain, but its flavor is not equal to that grown in England.

Poppies, too, are used for medicinal purposes, are they not?

Yes; poppies are cultivated for the sake of the ripe seed-vessel, which, as well as every other part of the plant, excepting the seed, is narcotic. The species so used is the *Papaver somniferum*, already described as yielding opium in foreign countries. It has beautiful white petals, tinged with purple at their base, and is said to be a native of Asia, but was early introduced into Greece, probably for the sake of the seed, which was used as food, and which yields an oil when pressed. The petals of the common scarlet poppy are collected for the sake of the coloring matter they yield. They also are slightly narcotic, and are used for making a syrup.

Is not a kind of Cucumber grown in this country for druggists?

Yes; the *Momordica elaterium*, a native of the south of Europe; it is a perennial plant with trailing stems, bluish-green in color, and bears a fruit like a very small cucumber, only rough and hairy; when ripe, this falls off, and from the hole left at the footstalk the juice and seeds are projected to a considerable distance; this property has given rise to its English name, the Squirting Cucumber, and appears to be a contrivance for its self-preservation. Its seeds and juice are used when nearly ripe: there is a green sediment thrown down after standing, and this when dried is a powerful medicine.

What is Saffron?

The dried stigma and part of the style of the *crocus sativus*, a beautiful lilac crocus; the stigmata are of a deep orange color, and when in quantities have a peculiar and characteristic odor. It is largely imported.

What a small portion of the plant to use—how is it prepared?

The flowers are gathered early in the morning, ju they are about to open; they are then spread on a t and the requisite part taken out. A mass of these stig some inches in thickness, is placed on sheets of paper o hair sieve; other sheets of paper and weights are plac the top, and the whole is roasted over a small kiln; produces a cake of saffron, but that which is not so pared, but merely dried in the sun, is the finest, and is c *hay* saffron. The beautiful meadow saffron, the *Colch autumnale*, which adorns our gardens in the latter pa the summer is an indigenous plant, and is also used in i cine; the parts employed for this purpose are its bulb i and dried, and the seeds.

There is a medicine called Aloes, is that made from plant?

Yes; it is the inspissated, or dried juice of the pla that name growing in the East Indies, Socotra, Cape of Hope, Barbadoes, and Arabia. It is of an intensely taste, and is a very useful medicine. There is an article called aloes-wood, which is not to be confou with the drug just mentioned; but is, in all probability aloes mentioned in the Psalms, in connection with n and cassia; from which, as well as from its being use Nicodemus for embalming the body of Christ, we may clude that it had aromatic properties.

What then is Aloes-wood?

It is the produce of a large forest tree growing in ea and tropical countries, and appears to be the result of eased action on some of the branches; the wood of such as are thus diseased is wholly valueless. It is in high r for fumigations, and as incense in all Hindoo, Mohamm and Roman Catholic countries.

What is the medicine called Bark?

A powerful tonic medicine first made known to peans in 1632, by the Jesuits, who found it in South Am The tree which is said to afford this bark is found o mountains of Loxa, in the kingdom of Quito; and on those of Santa Fé de Bogota; growing along their skirts, and on the plains under the fourth degree of north latitude, flowering from May to September. It is a spreading tree, rising from fifteen to twenty feet high, with a single erect round stem of no great thickness; and covered with a smooth bark externally of a brownish-gray color. The leaves of this tree are of a beautiful deep-red color in spring, so that the valuable trees are easily discovered. It was first called Jesuits' bark, because they brought it over to Europe, then Peruvian bark, and now Cinchona bark. Quinine, in which form it is extensively used, is the active principle of this bark combined with sulphuric acid; which is also in itself a powerful tonic. The tree is said to resemble the cherry-tree in appearance, and bears clusters of red flowers. The botanical name of the tree was derived from that of the Countess del Cinchon, the lady of a Spanish viceroy, who had been cured by it. The various forms of the bark are justly considered the most valuable tonic and febrifugal medicine we possess; they are classed under three heads—pale, yellow, and red barks. The *crown* bark, as the highest price is termed, is of a pale, yellowish red.

The manner of collecting the Cinchona bark is thus described: "The bark is cut by the natives in September, October, and November, during which time alone the weather is free from rain. The trees are felled close to the roots, sparing those which appear too young, as the bark is of no value until the tree has attained maturity. The bark is then cut lengthwise, and in a few days afterward the bark is removed in strips as broad as possible. Its value now depends on the celerity with which it is dried; in the dense forests this process cannot be hastened, and therefore the bundles of green bark are dispatched with all speed to the nearest inhabited place, where they are exposed to the action of the sun.

What is Rhubarb?

The root of the *Rheum*, or rhubarb plant; several species are supposed to furnish the drug, and it is not accurately known from which of them each variety is derived; it is brought to this country under the names of Russian, Turkey, and Chinese rhubarb. All that is called by the first two names is reported to grow on the declivities of a chain of mountains in Tartary, extending from the Chinese town Si-ning to the lake Ko-ko Nor, near Thibet. The soil is light and sandy, and the rhubarb is said to grow best in the shade, and on the southern side of the range.

How is Rhubarb prepared for the market?

In Tartary, the roots are taken up twice in the year, in spring and autumn, the body of the root is divided transversely into pieces of moderate size, which are dried for several days; a hole is then bored through each piece, by which it is hung up to finish drying. Part of this rhubarb is conveyed through Natolia to Turkey, and thence obtains the name of Turkey rhubarb, the rest goes to Russia, and is named after that country. In China, the roots are not dug up till winter, and after being cut into slices, are dried on stone slabs, with a fire underneath them, and afterward hung up, and exposed to the greatest heat of the sun.

What shrubs produce Senna?

Various species of Cassia; they are annual plants, natives of Upper Egypt, Central Africa, and India. The best kind of senna is the dried leaf of the *Cassia acutifolia*, some of which is called Tripoli senna. This species grows about two feet high and bears a yellow flower; the seed is contained in a legume.

What is Ipecacuanha?

The root of a creeping perennial plant, the *Cephaëlis Ipecacuanha*, which grows in moist, shady places in the forests of Brazil, and various other parts of the South American continent. It is a very valuable medicine, and has probably been used as such in its native country from time immemorial, but it was first brought to Europe about the time of Louis XIV., by a French merchant. Its name is said to be derived from *epi*, the Indian word for root, and *Cacuanha* the place where it grew most abundantly.

What is Sarsaparilla?

This also is the root of a plant; *Smilax sarsaparilla*, and there are several other species which possess the medicinal quality; *Officinalis*, *Medica*, etc. It grows in America and in the West Indies: it comes and looks like bundles of long slender twigs, covered with a brown or reddish wrinkled bark; it is in this bark that the medicinal quality resides. It is usually taken in the form of a decoction; the prepared sarsaparilla which you have seen in bottles, looking almost like treacle, is a very strong decoction of the drug boiled down with various other things.

What is Camphor?

A white crystalline substance, not exactly brittle, though it crumbles easily; it has a strong refreshing smell and warm acrid taste; it is so light as to swim on water; it burns readily with a bright white flame; so extremely volatile is it, that it entirely evaporates if left exposed to the air, and no trace remains of its having been there. This property gave rise to an amusing incident in a chemist's shop, where a little boy came in and said his mother sent him for "two-pen'orth of nothing;" he could give no clearer account of what was wanted, and after thinking, the chemist's assistant sent camphor, which answered the description more nearly than any thing else, as it would be nothing in due time if left alone, and it proved to be the article intended!

How is Camphor obtained?

It is the result of evaporating an essential oil found in two different trees, the *Cinnamomum camphora*, which grows in China and Japan, and the *Dipterocarpus camphora*, of Sumatra and Borneo: from these two trees it is obtained in very different manners. In the *Cinnamomum* it exists in root and branch, stems and leaves, and consequently these are chopped small and put into earthen vessels, which are heated; these vessels are covered with hoods, and rice straw is placed in them; the camphor is volatilized, and rises; it condenses on the straw, from which it is afterward cleared. It exists in the trunk of the other tree, the *Dipterocarpus*, in a solid form, and is obtained by cutting the tree down and splitting it open it is found in pieces from one to two feet long and about as thick as a man's arm; and a moderate-sized tree will yield about ten pounds of camphor, a large one perhaps twice that quantity. This kind is much more highly esteemed than the other, so that in Japan two hundred pounds of native camphor are valued at one pound of the Bornean.

What is Iodine?

This useful medicine, which is a deadly poison, is a peculiar mineral substance, existing in sea-water, sea-weeds, sponges, and many marine productions, as also in many mineral waters. It is obtained by digesting sponge or sea-weed in water and crystallizing the liquid, then mixing it with sulphuric acid and black oxide of manganese and distilling the compound; the iodine rises in beautiful violet colored vapor, which condenses into brilliant blackish scales. Its name is derived from the Greek, and signifies a *violet color*.

What is Castor Oil?

The produce of the seed of the *Ricinus communis*, or *Palma Christi*, a tree which sometimes attains the height of thirty feet, and in cold climates becomes an annual plant; it grows in Greece, the East and West Indies, South America and Africa, also on the rock of Gibraltar. The seed is enclosed in a rough, spiny nut; this bursts when ripe, and expels its three seeds. The oil was formerly procured by boiling them in water, but is now obtained by pressure; they yield by this operation one-fourth of their weight in oil.

What is Cod liver Oil? How is it procured?

Cod liver oil, as its name indicates, is derived from the liver of the cod. It is used extensively as a remedial agent, more especially for pulmonary complaints; "Its principal value seems to depend upon its nutritive qualities and the digestive powers of a portion of *pepsin*, or biliary matter, which is always present, and which may be detected by the application of a drop of concentrated sulphuric acid, when, if the oil be really cod-liver oil, a beautiful purple color will be immediately produced." The number of codfish captured is incalculable. The cod-fishers in opening the fishes to salt and dry them, carefully preserve the livers, for which an extra boat is usually in attendance; they are then taken on shore, and piled up in immense masses, exposed to the sun. The heat soon makes the oil run from the livers in considerable abundance, and for a short time is very clear, and of a light straw-color—this is the first quality and is kept by itself. As the livers begin to decompose, however, they give a darker color to the oil, and several qualities are obtained.

Is any other oil used in medicine?

Yes, Croton oil, which is an extremely powerful oil expressed from the seeds of the *Croton tiglium*, a native of the Molucca Isles and the Indian peninsula. It has a woody stem, and a soft blackish bark; the seeds are oblong and about the size of a coffee-bean. The oil when rubbed on the skin is extremely irritating and has a somewhat similar effect to a blister.

What are real Blisters made of?

They owe their irritating qualities to a kind of fly. This insect, the *Cantharis vesicatoria*, is common on various kinds of trees in Spain, Italy, and the south of France, and indeed to some extent all over Europe. Those used in this country are chiefly brought from Astrachan, and possess the irritating quality in a high degree. The insect is about two-thirds of an inch in length, and of a green-and-gold shining color, with long flexible wing-sheaths covering brown transparent wings. Cantharides are procured by smoking brimstone under the trees on which they are found, and then catching them on a cloth underneath, or they are simply shaken off, killed by the steam of boiling vinegar and afterward dried.

What is Gum?

Gum, or Gum-Arabic as it is called, is a clear sticky substance, which exudes from one or two species of Acacia growing in Arabia, also in Senegal, and some other parts of North Africa. The trees have a hard, withered aspect, with crooked stems and branches; the secretion of gum appears to be the effect of disease, as the greatest quantity is obtained from the sickliest trees, and during the hottest summers. It is quite liquid when it first exudes, but hardens by exposure to the air, and this without losing its transparency. It is gathered in July or August, when the weather is hot and parching. When stowed away it has a faint smell, it is also heard to crack spontaneously for many weeks after it is gathered. Gum is useful in medicine, as well as the arts, and its adhesive quality and ready use have made it almost one of the necessaries of domestic life.

What is meant by Gums and Resins?

Gums are vegetable exudations, generally clear and hard in their dry state, and sticky when dissolved in water. Resins are solid inflammable substances, also obtained by exudation from trees and plants; they are not soluble in water, but generally in spirits and in oil; there is an intermediate class called gum-resins, which are mostly obtained by wounding the trees which yield them; they are not quite soluble in either water or spirits, and do not burn so readily as resins, these latter being among the most inflammable substances known.

Are there many Gums and Resins?

The three species of gum most known are gum-arabic, already described, gum-Senegal, and gum-tragacanth. Gum-Senegal is, as its name conveys, obtained from Senegal, on the coast of Africa; there are two kinds of it, the red and the white, obtained from two different species of the *Acacia gumnifera*. It is found in larger and darker masses than gum-arabic, and is more sticky and tenacious; it is the kind chiefly used by calico printers. Gum-tragacanth, or gum-dragon, is white and opaque, and occurs in thin semicircular pieces, looking not unlike the paring of a horse's hoof; this kind is also more adhesive than gum-arabic, but resembles paste. Of resins and gum-resins there are a great many more, some well known and much used, and others seldom heard of; *turpentine* is probably the most familiar to you.

Tell me about Turpentine; where did we get it from, and how?

It is a resinous juice which exudes from the Scotch fir, *Pinus sylvestris;* it has a strong smell and bitter, disagreeable taste. It is collected in large quantities from the pine forests; the bark of the tree is wounded in March, when the sap begins to rise, and the turpentine continues to flow till October; it drips into a receptacle prepared at the foot of the tree, from which it is collected, and is afterward purified by setting it to liquefy in the heat of the sun; the barrels are perforated at the bottom, and it filters through. The trees do not produce turpentine until they are about forty years old, and those which are most exposed to the sun's rays yield the most.

Is there only one kind of Turpentine?

There are several beside the common: Venice turpentine, which is the produce of the larch, *Pinus larix*, and the best of which comes from the south of France; Canada balsam, which is obtained from the *Pinus balsamea*, a tree growing in the cold countries of North America; and China or Cyprus turpentine, which is brought from the north of Africa, the south of Europe, and adjacent islands; the tree which yields this kind is not a Pinus but the *Pistachia terebinthus.* All these turpentines, on being distilled, yield an essential oil, which is what is commonly called spirit of turpentine, not from its bearing any resemblance to spirits, but from both being the product of distillation. After the oil of turpentine has been obtained, a residuum is left, hard, brownish, and brittle; highly inflammable, easily melted, but insoluble in water, though readily uniting with oils; this is the *rosin* of commerce.

Will you tell me the names of some of the other Resins and Gum-resins?

Balm, or balsam of Gilead, myrrh, frankincense, benzoin, or gum-Benjamin, tacamahac, elemi, mastic, copal, sandarach, guaiacum, dragon's blood, and gamboge. Of these, copal and mastic are used in the composition of varnish, that made from the former being beautifully clear and hard; guaiacum and some others are given as medicines. Gum-sandarach when reduced to a fine powder is called *pounce*, and used to be much employed to prevent ink from running, where an erasure had been made on the paper. Other powders have also been called pounce, which are used by embroiderers to dust through holes pricked in a pattern, and thus transfer it to the cloth below; this kind is often made of charcoal, &c.

What is Balm of Gilead?

It is a resin obtained from the *Amyris Gileadensis*, a tree which appears to have been originally a native of Abyssinia, but to have been transplanted to Judea seventeen hundred years before Christ. It was held in high repute among the Jews as an almost unfailing cure for most diseases (a faith which the Arabs still hold), and this caused it to be an important article of export, even so long ago as the palmy days of the Israelites.

What is Myrrh?

A gum-resin obtained from a tree growing in Arabia Felix. The myrrh exudes spontaneously, first in an oily state; it then thickens, and from a yellowish white assumes a golden hue, and becomes hard and red when dry. It was esteemed of great value in olden times, even so much so as to be classed with gold and frankincense, in the offering which the wise men of the east brought to the infant Saviour.

What is Frankincense?

The substance now known by this name is a gum obtained in the form of tears from the spruce, *Pinus abies*, and some other species of fir-trees; but it is rather doubtful if the frankincense so often named in Scripture was the same article. All that is clearly known about this latter is, that it was a costly and fragrant resin, used as an ingredient in the incense burnt in the Jewish temple, and generally as a perfume; that it was procured from the Arab merchants, who obtained it from the shores of Africa, or possibly from India. Frankincense is often called *olibanum*, or *thus*.

What is Benzoin?

Benzoin, or gum-Benjamin, is a very expensive and valuable article, obtained from a tree called the *Styrax benzoin*, which grows in Sumatra and Borneo; it is principally employed as incense, and is equally desired for this purpose by Catholics, Hindoos, Mohammedans, and Chinese; it is also sometimes smoked with tobacco and other narcotics by eastern princes.

What is Dragonsblood?

It is a peculiar resinous coloring matter used very much in staining woods, and in coloring varnishes; it was formerly employed as a medicine, but is now gone out of use for that purpose. It is obtained principally from the Calamus-palm, which grows in Hindostan, Cochin China, the Mollucca Islands, etc. The ripe fruits of this palm are covered with the dragonsblood, which is collected and sent to Europe, wrapped in sheaths; it is either in tears, grains, or rods. Dragonsblood is also obtained by wounding the stem of the *Dracæna draco*, and the *Pterocarpus draco*—from this source it is obtained in large masses. It is usually sold in fine powder, and, as it readily dissolves in spirit, forms a convenient and useful coloring material.

You say Gamboge is a Gum Resin; do you mean the same kind as that used as paint?

Yes; it is the resinous juice obtained from a tree growing in Cambodia, China, and Siam, from the former of which countries it derives its name. The leaves and young stems are bruised, and from them flows a thick yellow juice, which is received into cocoa-nut shells, or small earthen vessels, and allowed to evaporate till it becomes quite hard; it then breaks with a bright vitreous fracture. It has no smell and little taste, but is extremely unwholesome, and, taken in large portions, *fatal*. It is used in medicine, but its greatest use is as a pigment.

What is Asafœtida?

A gum resin of an exceedingly strong and disagreeable odor, obtained by incisions into the roots of the *Ferula asafœtida*, a plant found abundantly in Persia. It is used for many medical purposes; it is antispasmodic and stimulant, and ranks high as a remedial agent for flatulence and indigestion.

What is Cream of Tartar?

A compound of potash with tartaric acid. In its impure state, in which it forms a gray or brown concretion, it is known by the name of argol or wine-stone, and is formed inside of the casks in which new wine is kept. The colored, impure, crude tartar is purified and dissolved, and the solution gradually evaporated; in this process crusts form on the surface of the solution, which are successively skimmed off; hence the name of "cream of tartar."

What is Strychnine?

The extract of a plant found principally in the tropical parts of Asia and America. *Strychnos nux vomica* is a native of Malabar, Ceylon, Coromandel, and other parts of India, growing in sandy places, and attaining the size of a tree, but short, crooked, and sometimes twelve feet in circumference. The fruit is about the size of a St. Michael's orange, with a bitter astringent pulp, and containing from three to five seeds. The pulp may be eaten, but the seeds are poisonous. There are other varieties of the order from which strychnia is derived, the *Upas tieute*, a climbing shrub of Java, being probably the most poisonous species of the genus.

What is Tar?

A thick, black, oily substance obtained from the roots and branches of fir-trees, by burning them in a close heat. It is prepared in the following manner: a conical cavity is made in the side of a bank or hill, an iron pan is fixed at the bottom of the hole, which has a spout projecting through the side of the bank; the roots and billets of pine-wood are then stacked very closely into the hole, and a covering of turf put over them, which is beaten with mallets to press it down, and make it as air-tight as possible. The pile is then kindled, and burns with a slow smothered combustion, which converts the wood into charcoal, the tar flowing out through the iron spout into barrels set to receive it; these barrels, as soon as they are filled, are bunged, and are ready for exportation. Pitch is obtained by boiling tar until it is quite dry; both are much used in ship-building, and for preserving wood-work, ropes, nets, and similar things from wet and decay.

What is Amber?

Amber is the resinous exudation of an extinct species of coniferous trees, formerly existing in great abundance in the northern hemisphere, and now washed or dredged up on the shores of the Baltic; it is found, but in less abundance, on the English coast. With it are sometimes found pieces of lignite, and the amber itself frequently encloses small insects and other organic substances. The outside of the amber is often marked with the impression of branches and bark, and the inside in one instance presents the corolla of an unknown flower.

About Woods.

Where do we get the Mahogany of which the parlor table is made?

The best comes from Cuba and is called Spanish mahogany; but the principal supply is from Honduras and some of the adjacent countries; it is the wood of a very large and magnificent forest tree, the *Swietenia mahogani*, which grows abundantly in the undisturbed forest of this part of America. This tree is remarkably elegant in its growth, and attaining so enormous a size both in height and spread of branches, is really a very striking object. It is usual for a party of the wood-cutters, to the number of about forty or fifty, to set off for the forest about the end of August; they mostly send a spy before them in the earlier part of the year to choose a locality fitted for their labor, and he conducts them at once to the spot. Having felled as many trees as they expect to be able to transport, they then set diligently to work to make roads to the nearest available river, cutting through forests, bridging rivers, etc. This work goes on till about March. The dry season then sets in, and the work of removal is begun; trucks being used for this purpose drawn by seven pairs of oxen, and attended by two drivers. Once arrived at the rivers, the logs of mahogany need no further care but that of seeing them safely through the rapids; and when they reach the coast they are stowed away in the holds of vessels, the spaces being filled up with cocoa-nuts.

Was there no Mahogany used before the discovery of America?

No; before that time oak and walnut were the woods most used to supply the place mahogany now fills. Sir Walter Raleigh is said to have been the first person who used this wood, and he employed it to repair his ships at Trinidad. The captain of a West Indiaman afterward brought some of it over as a present to his brother, who tried to use it in building, but the workmen grumbling that it was too hard, he had some made into a candle-box, which was so much admired for the beauty of its markings and color, that one or two articles of fancy furniture were made of it for persons of distinction, and thus it became fashionable at first; more was imported, and it has of latter years been very common.

What is Rosewood?

A Brazilian wood, very hard; the color consists of dark zones on a reddish-brown ground. It is a richer and more costly wood than mahogany.

What is Satin-wood?

A species, *Chloroxylon swietenia*, a native of the East Indies; the wood is of a light yellow color, and is denominated satin-wood from its silky aspect; it is remarkably close-grained, heavy and durable.

Tell me about Oak and Walnut wood—where do they grow?

They are natives of this country. The oak, *Quercus robur*, is the finest timber tree of this country, growing slowly, but to a great size, and sending out large and rugged arms; the wood of this tree is employed for ship-building on account of its durability when exposed to wet, and its unwillingness to crack; it is used for machinery, where great strength is required, and also for many household articles. In former times, when oak was not so scarce as it is at present, floors, staircases, &c., used to be made of it. Black walnut has become a fashionable wood for cabinet-makers' work; it is very richly and beautifully veined, and is appreciated for the richness of effect its dark tints produce.

Will you tell me what some of the other woods are used for?

The wood of the chestnut, *Fagus castanea*, is considered next in value to the oak for all those purposes which require great durability. The beech, *Fagus sylvatica*, is a light, brittle wood, easily wrought, and chiefly used by turners and cabinet-makers for articles not requiring much strength; and this may be said of most of the *poplar* tribe, whose timber is of little value. The wood of the elm, *Ulmus campestris*, is hard, tough, and durable, bearing well to be kept constantly wet, and is much used for boats and mill-wheels, as well as for the strong parts of wagons, gates, etc. The ash, *Fraxinus excelsior*, too, is very useful for these latter purposes and for all sorts of farming implements and dairy utensils, it is also frequently cut when young for poles, for which it is well suited, being very tough. Maple, *Acer campestre*, is chiefly known as a fancy wood, used by the turner and the cabinet-maker; it is curiously spotted and marked. Cedar is a wood of a brownish-red color; has a well-known agreeable odor, and is very durable, being unattackable by insects. It is soft, of a uniform texture, and light.

What is Deal?

The wood of different species of the fir tribe; it is cheap, light, and easily worked, it splits readily however, and is not very durable; it is also highly inflammable.

What is Box-wood?

A very hard, smooth, compact, fine-grained wood, of a pale yellow color; it is used for fine carving, for turnery, for making combs, flutes, shuttles, mathematical rulers, and is the wood of which are made the blocks on which are cut the innumerable wood-engravings which adorn and illustrate our books and newspapers; it is brought from the Levant.

What is Ebony?

It is a hard, black wood, brought principally from Madagascar, the Mauritius, Ceylon, and other parts of the east; it is very heavy and durable, and will take a very fine polish; it is too costly to be used except in comparatively small quantities, but is much esteemed for inlaid work as well as for the manufacture of various small articles. The ebony-tree is called *Diospyrus ebenius.*

What is Sandal-wood?

Sandal-wood, or *Red Sanders-wood*, is a wood of the *Pterocarpus santalinus*, a tree which grows in Ceylon and on the coast of Coromandel. When the tree becomes old, the harder central wood acquires a yellow color and great fragrance, while the softer exterior wood remains white and possesses no fragrance. It is the yellow wood only which is esteemed for its perfume, and from which boxes and cabinets are made. A coloring matter is obtained from the wood called santaline, which is much used by the dyers.

What is Cork, and where does it come from?

Cork is the soft, spongy external bark of a species of oak-tree, which grows abundantly in Spain, Portugal, etc. It is not the living bark which is collected for cork, but that which is dead, and which, no longer growing with the tree, is pushed off by the rapid growth of the inner bark, and forms loose layers such as those we often see. The cork-tree is the only European tree which produces so thick and spongy a bark.

What is Brazil-wood?

A valuable wood imported from South America; the trees are large, with repeatedly pinnated leaves, showy yellow flowers, and long richly-colored stamens. It is used for the preparation of a red dye. The color given to silks known as false crimson, is by means of Brazil-wood. The silk is boiled with twenty parts of soap, rinsed, and passed through a bath charged with this wood.

In cabinet-making, what is Buhl?

Inlaying is a mode of ornamenting furniture, by which a peculiar richness and gayety is obtained. When the inlaying is done with various kinds of wood, it is called *marquetry*, but when inlaid with brass or tortoise-shell, it is called *buhl.* This latter process is said to be named after a German, who first invented it. The ornamentation of buhl is complicated; ebony, or some dark wood is usually the material upon which the inlaying is effected. When tortoise-shell is used, it is commonly laid upon a red ground, which shows through the transparent part of the shell. Brass patterns are let into a ground of tortoise-shell; and sometimes tortoise-shell is inlaid with the brass.

Marquetry is very ancient. Formerly, it was only executed in black and white; and it is stated that the first to use a variety of colors was John of Verona, who was contemporary with Raphael. The art was a favorite among the French of the seventeenth century. Marquetry is not confined to simple forms; fruits and flowers have been successfully represented by its aid, the woods being stained for the various tints required.

How are the curved forms in cabinet-work obtained?

They are sometimes cut out of the solid wood, but this is exceedingly expensive when the wood is of a rare kind. Another mode is, to soften the wood by steam, then bending it to the desired shape, and permanently retaining it there by drying. The method is more practised in Russia than with us, where it has been applied even to working cart-wheels.

How are woods stained for inlaying?

A red stain is produced by an infusion of Brazil-wood impregnated with pearl-ash; pink is secured by a solution of the Brazil-wood stain; a yellow stain is made with the tincture of turmeric; blue is obtained by indigo; green, by verdigris dissolved in vinegar; and purple, by a combination of logwood and Brazil-wood.

What is Bamboo?

A cane that grows in China, and very extensively used for a vast variety of purposes—for all kinds of furniture; for sails, cables, rigging; for carts, wheelbarrows, fences, sacks to hold grain, various utensils, baskets, etc. The young shoots are even used for food; its fibres serve for wicks to candles, and it is also twisted into cordage, and manufactured into paper. It is one of the most common plants of the country, attaining a height often of forty feet, with a stem perfectly straight, hollow, and jointed, and covered with a thin hard coat which appears like a varnish. Furniture made of it is light, strong, and portable, and is usually so made as to fold up into compact shapes. The ratan, of which the seats of cane chairs are made, is a small sort of cane brought from China and Japan. It is exceedingly tough; in China it is twisted into cables.

About Minerals.

What is a Diamond?

It is a gem or precious stone; pure, clear, and white, so brilliantly reflecting the light, that it shines and sparkles in an almost dark room. It is the hardest substance known, and can only be cut, shaped and polished by means of its own dust, which is also the best material for polishing all hard, impracticable stones.

Where are Diamonds found?

They were formerly brought from the celebrated mine or mines of Golconda, in India, but these are said to be nearly exhausted. Some of the larger islands of the Indian Archipelago have yielded valuable diamonds, but the greater number now come from the Brazils, in South America. These gems are frequently found in beds of torrents, by which they have been dislodged and conveyed away. Diamonds are generally small, and are hence considered of value in proportion to their *size*, as well as their clearness, some very large ones being reputed to be worth incredible sums of money. The largest and most valuable diamond now known is the Koh-i-noor, or Mountain of Light, belonging to Victoria; it came from India, having formerly belonged to Runjeet Singh. It was exhibited at the Great Exhibition in 1851.

Are Diamonds found all bright and glittering as you describe them?

No, they are covered over with a thin crust, which, however, is readily removed; they are then found to be octahedral crystals.

Are all Diamonds always white?

No, the white ones are the most valuable, but there are others which are much admired; these are rose-colored, blue, or even black; light-colored ones, and those which are even in the least degree deficient in transparency, are of less value. This gives rise to the terms used in speaking of the quality of these stones—the finest are called diamonds "of the first water," while inferior ones are said to be of the second water, or the third water.

Are these colored diamonds what are meant by rose diamonds, which I sometimes hear spoken of?

No, that term refers to the shape into which they are cut. A rose diamond has one side flat, and the other raised and cut into a number of flat faces, called facets; a brilliant is much thicker in proportion, and has both sides raised. Now tell me, if you can, to what the diamond is most nearly allied?

I cannot guess; to some beautiful mineral which I do not know perhaps.

No, you know it very well, for it is none other than coal—black, dull, opaque coal, which is the nearest relation the diamond has in the mineral kingdom. The learned have discovered that the diamond consists of pure carbon, and charcoal is pure carbon also; the only known difference being that one is crystallized and the other not. The true nature of the diamond was demonstrated by the following experiment. A diamond was enclosed in a cavity made in a piece of soft iron, a stopper of the same metal was driven into it, and the mass was put into a crucible, and this into another, the space between them being filled with sand. The whole was then subjected to an intense heat. When examined, the diamond had disappeared, but the iron with which it had been in contact was changed into steel. Steel is a compound of iron and carbon; as there was no source from which the carbon could have been derived, the conclusion was unavoidable that the diamond was pure carbon. Other and various experiments establish this fact beyond doubt, extraordinary as it may appear.

Tell me the names of some other Gems, will you? I know there are some more.

Yes; there are the emerald, ruby, turquoise, amethyst, topaz, garnet, onyx, sapphire, opal; and agate, jasper, and cornelian, though they do not rank among gems, are often used for ornament.

I know the Emerald is green, where does it come from?

The finest emeralds come from Peru, and other parts of South America, though they are sometimes brought from the east. They are of a beautiful clear-green color, some very dark, others paler, and are much valued and used for ornamental jewelry. The Queen of Spain's emeralds were among the most beautiful jewels shown at the Great London Exhibition. Rubies are very striking gems, being, when of the finest sort, of a beautiful dark-red color, and very clear; they are not, however, often of large size, and are not so hard as many other gems—the emerald for instance. There is an inferior kind, of a pale-rose-color, which are brought from Balachan, in Turkey.

The sapphire is generally called a blue gem, and that is the color intended when people talk of a "sapphire hue," but it varies so much in color that there are sapphires which resemble, and as it were, counterfeit other gems; these are called oriental emeralds, topazes, or whatever other stone they resemble. The red sapphire, or oriental ruby, is one of the most valuable gems, coming next after the diamond. Some sapphires present when polished a beautiful effect, from a six-rayed star of light gleaming in their centre. This is the effect of the six-sided form of the crystal.

What is the Carbuncle?

A gem of a beautiful deep-red color, with a mixture of scarlet, found in the East Indies. It is usually found pure, of an angular figure; its usual size is nearly a quarter of an inch in length, and two-thirds of that in diameter. When held up to the sun it loses its deep tinge, and becomes exactly of the color of a burning coal.

Is the Opal a clear gem?

No, it is only partially clear, and its great beauty consists in the play of colors from its interior: yellow, red, and green, the most exquisite tints, flash and gleam from it as it is moved about. The finest opals are as valuable as diamonds; they are brought from Turkey, and sometimes from Hungary, but it is seldom that any are found of large size.

What kind of gems are the Amethyst and Turquoise?

The amethyst is a clear, hard stone of a beautiful violet color by daylight, but looking brown by candlelight; it is nearly related to the quartz rock-crystal, which is used for making spectacle glasses, and sometimes for false diamonds. We get the finest amethysts from Ceylon, the Brazils, and the southern part of Spain. The turquoise is an opaque stone of a blue color; it is very soft in comparison with most gems, and is therefore often used for engraving upon; it is very easily imitated, and consequently a large proportion of cheap jewelry pretends to be adorned with turquoises.

Of what color are the Topaz and Garnet?

The topaz is of a bright golden yellow; the garnet, of a good deep red; the latter is not very valuable, though very pretty. In some places small garnets are crushed to use instead of emery; and in Germany, where garnets are very abundant, they are sometimes used as a flux for iron ore. The topaz is found in several parts of the East Indies, in Ethiopia, Arabia, Peru, and Bohemia; the oriental are the most esteemed. They can easily be imitated.

You have told me nothing about the Onyx yet; what is that like?

The onyx, the agate, the cornelian, the sard, and sardonyx, are only differently marked and colored varieties of one stone, which is called *chalcedony*. This stone in its pure state is colorless, or only tinted bluish gray, but other matters are sometimes present in it, and then it varies in color; the sard is deep-red brown; the sardonyx, layers of brown and white chalcedony; cornelian is usually either red or white, and always clear; the agate is found in various colors, and has many markings, sometimes angular or zigzag, in which case it is called a fortification agate; sometimes straight lines of color give it a banded appearance, it is then called ribbon agate; another kind has markings quite different, and is called a moss agate. The onyx has layers of different colors, and advantage has been taken of this for cutting it into beautiful ornaments. A head or group of figures is carved by the artist from the white layer of stone, leaving the background dark, or else the figures stand up dark and clear, relieved by the snowy background. Gems cut in this manner are called cameos.

I remember now to have seen many of these cameos, and thought they looked as if made of two separate stones. Is it a modern invention to cut them thus?

No; the Greeks and Romans possessed the art, and many specimens remain of their work, which will never be surpassed in beauty, and which are now valued at enormous sums. Glass imitations of these antiques are now not unfrequent, and are often such beautifully exact copies, both in outline and color, that no one can distinguish the difference between them. Cameos are also made from the lip of the helmet-shell, a large thick shell which is formed of layers varying in color like the onyx. I have before told you how glass imitations of diamonds, emeralds, and other gems of the kind are made, as well as many other glass ornaments.

Are there any jewels which are not stones?

Yes; pearls are generally considered jewels; they belong to the animal, and not to the mineral kingdom. These are round bodies, white and shining, with a peculiar and beautiful lustre, for which we have no other adjective than *pearly*. They are supposed to be the effect of disease in the fish inside whose shells they are found, as they are not by any means found in all the shells. Various shell-fish yield pearls, but the finest, and by far the most frequent, are those produced by a peculiar kind of oyster, called from this circumstance, the pearl-oyster. The most abundant fisheries are near Ormuz in the Persian Gulf, and on the coasts of Ceylon, though they are obtained in many other parts of the east, and indeed of the world.

How are they fished up?

Expert divers go out in pairs or threes in boats or rafts to the fishing ground, and then they cast anchor, and one of the party, having fastened to his body a heavy stone to serve as ballast, a net to contain his oysters, and a rope by which to be hauled up again, goes overboard, and sometimes dives to the depth of sixty feet. He immediately commences garnering the oysters, which often adhere firmly to the rocks; when his net is full, or he can no longer hold his breath, he pulls the rope, and his comrades above haul him up again; sometimes, alas, this is not done in sufficient time to save him from the sharks and other voracious creatures which haunt these pearl beds, and he loses life or limb in his perilous undertaking! When the oysters are taken on shore they are heaped into shallow pits, and covered with sand; they soon open and die, the fish rots away, and the pearls fall out. They are then cleansed and sifted, and are valued according to their size; large round or perfectly pear-shaped pearls are the most highly esteemed, and they should be quite white, not tinged with any other hue.

Glass beads made in imitation of pearl for toilet ornaments, the invention of which dates from the year 1656, are small, solid glass beads, of the same size as native pearls, which they are made to resemble by a coating of varnish, which gives them a peculiar pearly lustre and color. A maker of rosaries, by the name of Jaquin, was the first to discover that the scales of a species of fish, *Cyprinus albunus*, commoncate a pearly hue to water. Based upon this observation, glass globules were first covered on the outside, but at a later period on the inside, with this aqueous essence. The costly essence, however, of which only a quarter of a pound could be obtained from the scales of four thousand, was subjected to one great evil, that of decay. After trying alcohol without success, in consequence of its destroying the lustre of the substance, sal-ammoniac was at length found to be the best medium in which to apply the essence; a little isinglass is also mixed with it, which causes it to adhere better. The pearls are blown singly at the lamp; a drop of the essence is then blown into them through a thin tube, spread out by rolling; and the dried varnish is then covered in a similar manner by a layer of wax.

What is Asbestos?

A curious mineral which consists of long silvery fibres; there are four or five varieties of it, named after their different appearances. It possesses the remarkable property of being almost indestructible by fire, and on this account was highly prized by the nations of antiquity, who spun and wove it into cloth, with which they used to form shrouds, in which the bodies of royal and illustrious persons were arrayed at the funeral pyre; as the asbestos cloth did not consume, the ashes of the departed were thus kept from mingling with those of the wood, etc. It is said that the Brahmins sometimes made themselves clothes of it, and also employed it for wicks to their perpetual lamps, etc. In Europe, at the present day, asbestos-cloth is considered more as a curiosity than in any other light; but a new use has been found for this curious mineral—the fibres of it, which appear to burn without being consumed, are employed to fill a newly-invented kind of gas stove, the numerous jets of which supply the blaze, and heat the asbestos red-hot.

Where is Asbestos found?

In the silver mines in Saxony, also in Sweden, Corsica, and many other parts of Europe, as well as in America.

What is Talc?

Talc is a whitish-gray mineral, found in rocks of serpentine, mica schist, and gneiss. It is readily split into plates, which are flexible, transparent, and not elastic. It will bear great heat, and is used for stove-windows, where glass would crack.

What is Emery?

A mineral, of a blackish-gray color, chiefly brought to this country from Naxos, an island in the Archipelago, but found also in Germany, Italy, and Spain. It is reduced to a fine powder by trituration, and is much used in polishing glass, metals, and other hard bodies.

What is Pumice-Stone?

It is a kind of light, spongy, vitreous stone, which looks as though formed of glistering threads slightly united. It is found in the vicinity of volcanoes. The island of Lipari, in the Mediterranean, is said to be the chief source from which Europe is supplied with this useful article, the whole body of the island appearing to be formed of it. There are several different kinds of pumice-stone, but those only are imported which are light and spongy. Pumice-stone is used for polishing metals and marble, and for smoothing the surface of wood and pasteboard. House-painters use it for rubbing off old paint before they apply the fresh coat.

What is Fullers'-Earth?

A kind of clay, which is employed to take the grease out of wool and woollen fabrics, before the application of soap. It is opaque, soft, and greasy to the touch, and falls to powder on being put into cold water. Its remarkable detersive quality is derived from the alumina which it contains, sometimes to the amount of one-fourth or one-fifth of the whole.

What is Alum?

It is a white semitransparent substance, much used in the arts, especially in dyeing; for it acts the part of a mordant, fixing or brightening many colors which would otherwise be fugitive or very dull. It is astringent, and has a sharp acrid taste; it is soluble in water. Alum is a compound substance, consisting of alumina, or pure clay, potass, and sulphuric acid. It is sometimes found native, but by far the larger proportion of that which we use is manufactured. The best alum is that which comes from Civita Vecchia, in the Roman States; it is in irregularly crystallized masses, about the size of a walnut. Rock, or as it should be written, rocche-alum, is of a pinkish hue, it comes from Smyrna, it was formerly made at Roccha, in Syria, whence its name. English alum, for the manufacture of which there are several works in the north of England, is esteemed the least valuable kind.

What is the Loadstone, is it not a mineral substance?

Yes; and it is one to the discovery of which, and its application by science to the purposes of common life, we are indebted for perhaps more of our comfort and safety, more advance in civilization, than to any other mineral, unless, perhaps, we except iron; and even iron need not be excepted, as loadstone is clearly proved to be an ore of iron. This curious substance, which is of a dark color, rough, and unattractive in external appearance, has the property of drawing to its surface any piece of iron or steel with which it may come in contact, and holding them fast, as by some invisible power. It can also impart this attractive force, which we call *magnetism*, to iron or steel, so that they also in their turn can attract other pieces. The property in which the chief value of the loadstone consists, is not, however, this magnetic force, but its power of always turning toward the pole, so that by its aid the sailor on the trackless sea, the wanderer over unknown lands, can always discover the direction in which he is travelling.

I know to what you allude, it is to the Mariner's Compass.

Yes; this little instrument, which consists of a small, round box, marked with the north and south, and various other points, and a needle of magnetized steel, so balanced that it can turn freely in any direction, is the most useful application of the powers of magnetism. The honor of having discovered this property in magnets, and first using the compass, is attributed to a Neapolitan, named Flavio Giola, who lived in the thirteenth century, though there are many claimants for this honor, both among the nations of Europe and the east, the Chinese, as usual, being said to have been fully acquainted with its use long before the time of its discovery in Europe. It is well known that the ancient Greeks and Romans were acquainted with the loadstone, and many of its uses, but they do not appear to have discovered its polarity, and consequently all their vessels were afraid to go far out of sight of land, and could only steer their course by observations of the sun and stars. The word magnet is said to be derived from Magnesia, a country in Lydia, where this loadstone, or natural magnet, was first discovered, and there is the more reason to conclude that this is the case, because it is often called in old manuscripts *Lapis Heracleus*, from Heraclea, the capital of Magnesia. The name loadstone is of northern origin, and signifies leading or leader stone.

Why does the loadstone point to the pole?

You have asked a question which it would puzzle some of the most scientific heads to answer, but though the whole question involves one of nature's deep mysteries, I think I can make the reason a little more clear to you than it is at present. This magnetic influence which we have been talking about, is called the *magnetic fluid*, and it is supposed not merely to exist in loadstone, but to pervade every particle of matter, to such a degree as to convert the whole earth into one great magnet, and the poles or points to which the fluid is attracted, so nearly coincide with the poles of the earth's axis, that with a little allowance for the variation of the needle, which modern science enables us to do very accurately, the direction of the north pole may always be taken to be that indicated by the pointer of the magnet. It has been proved, that if little magnets be placed on a much larger one, their north poles are attracted to its north pole and deflected from it in just the same manner.

Then have all magnets two poles?

Yes; and it is a curious circumstance that the north pole always attracts the south, and the south always attracts the north, repulsing all those of the same name. Thus with a common steel-bar magnet you may attract a needle or group of steel filings with one end, till they all cluster like a swarm of bees around it, and with the other end you may drive them all away.

What is Marble?

It is a beautiful hard stone, occurring in the beds of mountain limestone which underlie the coal measures. The chief ingredient is lime, and some of those from the upper beds contain fossils of corals and madrepores, and other similar marine animals. Indeed wherever there has been sufficient heat to fuse and crystallize rocks consisting chiefly of lime, marble has been formed. All the kinds of marble are capable of receiving a very fine polish, and are useful, the finer sorts for statuary, and the coarser for altars, columns, hearth-stones, chimney-pieces, fountains, for ornamental building, and many other uses.

Are there many kinds of Marble?

Yes, an almost infinite variety; the colors and markings vary so very much, as well as the grain and quality of the stone, that there are hardly two quarries which produce exactly the same kind. The most esteemed white marble is all imported from Italy, or from the island of Paros in the Grecian Archipelago; the former is called Carara marble, the latter Parian, and it was of this kind that the exquisite sculptures of the Greeks were formed. There is also a black Carara marble, which is much prized.

What is Alabaster?

A white kind of stone, not much unlike marble, but softer and slightly translucent; it is used for smaller statues and carving for many little ornaments, which, from its greater softness, can more easily be worked in alabaster than in marble.

What is Jasper?

An opaque flint, which resembles dry clay. It is capable of fine polish, and its color is generally reddish. It is composed of silicious earth, united to alumine very full of iron.

What is Meerschaum?

A Magnesian mineral, found in the island of Samos, and Negropont, at the foot of Mount Olympus, etc. When first dug up it is soft, greasy, and lathers like soap; and is on that account used by the Tartars in washing their linen. The well-known Turkey tobacco-pipes are made from it by a process analogous to that of making pottery ware. The bowls of the pipes are prepared for sale by soaking them first in tallow, then in wax, and finally by polishing them with share-grass.

You have told me of a great many mineral substances, and you often allude to their position in this rock and over that one, I wish you would be so kind as to tell me how the rocks are arranged.

That I will gladly do, though I can only give you a very rough sketch, but you must first dismiss your idea of shelves, or at least retain it with the clear remembrance that those shelves, by which we would describe the different strata of the earth's crust, are all tossed about and upset, so that in many cases those that should be at the bottom now lie at the top, and form the summits of the loftiest mountains, while those which have been most recently formed, and would consequently be at the top if all were undisturbed, now fill up the valleys and occupy the lowest position.

Why do you call it the earth's crust?

Because with all our prying and examining, and with all the assistance which we have derived in our researches from the dislocated and disturbed position of the rocks, we have only been able to penetrate to a depth of a few miles into the earth, some geologists say eight or ten miles, others twenty; but whichever it be, it bears no greater proportion to the earth's whole diameter, than does the rind of an orange to the whole diameter of that fruit; so we call all the explored space the earth's rind or crust. Inside this crust none can tell what exists, though there appears every reason to believe in a central fire, surrounded by red-hot liquid minerals, of which some are occasionally forced to the surface, when the irruption of a volcano gives vent to these fires below. These substances cooling beneath our atmosphere, with no pressure, become light and cindery, full of holes, and porous, like pumice-stone, but when they cooled under immense pressure from above, they formed hard, solid rock. This is the kind of rock of which the lowest shelf is formed, the primary or first series; and granite is the most important and best known of the group; it is not a simple material, but is composed of crystals of quartz, felspar and mica, which gives it the peculiar glittering appearance with which we are all so familiar.

Where do we obtain Granite?

Granite is abundantly distributed over the northern part of the American continent, as in the Canadas and the New England states. In New Hampshire it is the predominating rock of the White Mountains. In all these places the granite has been upheaved from below after it was cool and solid, in such a manner as to tear asunder the strata disposed upon it, and tilt them up upon its sides. Granite contains cracks and veins, which are mostly filled with ores of copper, iron, silver, gold, and tin; the emerald and topaz are also found in granite, and beautiful white quartz, as clear as crystal. Above the granite lies a small group called metamorphic rocks, because they were originally deposited by water, and have since been baked by heat into a crystalline form; they contain no fossils, and appear chiefly, if not entirely, formed of the broken materials of granite, rearranged; they comprise gneiss, mica slate, and other kinds of slate, such as are used in roofing. Slates also appear in the next group, the transition rocks, their laminated structure showing so plainly how they were formed at the bottom of a quiet sea, and their crystalline nature how the intense heat has changed them.

Where do we get Slates from?

Mostly from Wales, where there are large beds of them; they are quarried by blasting immense blocks with gunpowder, and they then split readily in the direction of their layers. Upon these slates lies a deep bed of mountain limestone, mingled with and overtopped by beds of hard sandstone. The limestone is the same which I have already mentioned to you as containing beds of marble, that beautiful mineral being little other than crystallized limestone, colored by various substances; sand and other materials less fusible than lime have not become crystallized, but only baked into hard sandstone. Many of these transition rocks contain curious fossils; the lower strata have only sea-weeds and corals, but as ages rolled away the scale of living things rose, till beautiful fishes peopled the ocean, whose fossil remains are preserved in the old red sand-stone, and grand forests arose, the story of which is recorded, as I have already told you, in the coal-measures.

Do these rocks lie regularly above the older ones?

No; I forgot to tell you that the rocks of this transition series do not follow the upheavings of the granite and other hard rocks below, but rest upon them as if they had been poured out fluid after the other rocks had attained their present position; and though they have been abundantly torn up and disturbed, it has been by more recent upheavings.

What came next after the coal-measures; for I suppose some terrible convulsion broke up that order of things, as others had been before it?

Yes, there was a violent disturbance, which dislocated these strata, and in many cases shivered them to fragments; finally they were buried deep in thick strata of softer stone, sand, etc., which contain no metallic veins, but deep beds of salt, drifted remains of plants, fossils of corals, crustacea, shells, fishes, and huge reptiles, frogs, lizards, and similar creatures, with the footprints of various birds. All these immense collections appear to be the refuse—*detritus*, as it is called—of vast continents now no longer existing, or sunk beneath the surface of the sea, torn away and borne onward by the force of mighty rivers. The rocks which form this group include many very useful building-stones, among which may be named the Portland stone, and the Bath stone, which latter, with some others, possesses the good quality of being soft, and easily worked at the quarry, but hardening afterward by exposure to the air. Time would fail me to tell you of all the changes that took place during the deposit of this secondary formation, from the stormy days of the new red sandstone —through the quiet lias which was formed below the depths of the sea, and contains multitudes of fossils, both from the sea and from the shore; the oolite, which was sometimes above and sometimes below the sea level, now preserving in its stony pages the traces of a muddy shore, and now those of an inland forest; the wealden, which is almost entirely fresh-water, and contains the remains of animal life on a larger and more perfect scale than any other of the group; up to the chalk, the last *rock*, not only of this series, but of the whole geologic scale.

I know Chalk, it is white, is it not?

Yes; it is chiefly known as a dense white substance, imbedding nodules of various sizes formed of flint, and often containing, both in flint and in chalk, beautifully preserved fossils; but in some countries it is gray or reddish. Chalk is, as you already know, little other than consolidated lime. In the tertiary formation which comes next, is found the first sign of the dawning of the present state of things, the numerous strata of clays and sands which compose this group, some of which are marine and some fresh-water, contain fossils of creatures similar to those which exist at the present day; few, indeed, in the lower part of the series but increasing rapidly as they proceed, until at last among beds of fossil shells, ninety per cent. are like those now in existence. Still, however, the larger fossils are those of extinct groups of animals, or, if not of extinct groups, they are species which have passed away, though intimately related to recent ones. Most of these creatures, and those contained in the beds of drift which lie upon the tertiary group, are of enormous size; elephants of fifteen to eighteen feet in height, and of proportionate dimensions; stags and many other animals, besides the great megatherium and mastodon, of which we have no type now extant. Some of these great beasts have been preserved whole, in the icebergs of the north, and have been found with flesh and skin all on, looking as perfect as when alive.

Having now traced up for you the order in which the shelves, as you call them, of nature's great storehouse are placed, and sometimes indicated to you what may be found upon each of them, placed there by the hand of an all-wise, almighty, and beneficent God, for our use, and for our instruction, that we may read on these tables of stone his goodness and greatness, and our own utter insignificance and helplessness. I will relate to you a fable, which, though written in the thirteenth century by some Arabian author, before geology was thought of as a science, gives a just notion of geologic changes, and as such has been quoted, by several eminent geologists. The narrative is supposed to be given by Rhidhz, an allegorical personage.

"I passed one day by a very ancient and populous city, and I asked one of its inhabitants how long it had been founded? 'It is indeed a mighty city,' replied he, 'we know not how long it has existed, and our ancestors were on this subject as ignorant as ourselves.' Some centuries afterward, as I passed by the same place, I could not perceive the slightest vestige of the city. I demanded of a peasant who was gathering herbs upon its former site, how long it had been destroyed? 'In sooth, a strange question,' replied he, 'the ground here has never been different from what you now behold it.' 'Was there not,' said I, 'of old, a splendid city here?' 'Never,' answered he; 'so far as we know, and never did our fathers speak to us of any such.' On my return there again after the lapse of other centuries, I found the sea in the same place, and on its shores were a party of fishermen, of whom I inquired, 'How long the land had been covered by the waters? 'Is this a question,' said they, 'for a man like you? this spot has always been what it is now.' I returned again ages afterward, and the sea had disappeared, I inquired of a man who stood alone upon the ground, 'How long ago the change had taken place,' and he gave me the same answer that I had received before. Lastly, on coming back again, after an equal lapse of time, I found there a flourishing city, more populous and more rich in buildings than the city I had seen the first time; and when I would have fain informed myself regarding its origin, the inhabitants answered me, 'Its rise is lost in remote antiquity; we are ignorant how long it has existed, and our fathers were on this subject no wiser than ourselves.'"

About Fermented Liquors.

What is Beer made of?

It is composed of malt (about which I told you when I was speaking of barley) and hops, which possess a strong bitter and astringent quality, which is very useful in causing the beer to keep longer; hops also contain a narcotic principle. The addition of hops to beer is a comparatively modern invention; they were introduced from the Netherlands in 1524; the English beer of the middle ages was a thick, sweet liquor, which would not keep at all.

What are Hops like?

They are the seed-vessels and seeds of a climbing plant, the *Humulus lupulus*, which is not uncommon in our hedgerows and wayside places, but which when intended to be used for brewing, needs to be cultivated with the greatest care; as it requires very rich strong soil, and constant training, weeding, etc. A hop-garden presents a very pretty sight when the hops have climbed up the poles placed for their support, and long pendants and streamers floating from their tops; the prettily-divided leaves and clustering hops are very elegant. When the crop is ready, the plants are cut off at the root, and the pole, with the climber all twisted round, is drawn out of the earth and laid across a bin, into which the hops are picked, women and children being often employed in this work.

You have not yet told me how Beer is brewed.

The malt is first put into the mash-tub, and warm water added to it, not boiling water, which would spoil it all; this soaking in warm water dissolves all the ready-formed sugar in the malt, and assists to convert some of its remaining ingredients into sugar also, and then to dissolve them. When the liquor, which is now called sweet wort, has stood to settle, it is drawn off into the copper, where it is boiled with the hops. It is now beer, but unfermented. When it is cooled down to between fifty and sixty degrees, it is put into the fermenting tun, a sufficient quantity of yeast is added, and it is allowed to ferment for about six or eight days.

Is Beer ever made of any thing else beside Malt and Hops?

Yes, a great number of other ingredients are sometimes added to it, some with a view of increasing its intoxicating properties, some to alter its color or its flavor, and some to make it cheaper. In other countries, beer, or a similar beverage, is brewed from various substances. Thus, in Russia, a thick, muddy, hard kind of beer is brewed from rye, which is not prepared by malting, but is used in the state of flour, and fermented with the addition of yeast. This strange and to our palates most disagreeable beer, is called quass, and is a very favorite drink with the Russians. Another kind of beer is made by the Indians and half-castes of South America, from roughly malted maize—it is called chica; it is a dark-yellow liquor, with a slightly bitter, slightly acid taste. The term *chica*, though originally applied only to this maize beer, is now applied to all the fermented liquors of this region, whether made from barley, rice, peas, yuccas, pineapples, grapes, or even bread. In some parts of Asia bordering on Russia and the Black Sea, beer is brewed from millet; rice is also used in Java and some other places; thus you will see that the *cereals*, already described in another place, are the class of plants from which we obtain the chief materials for our fermented liquors, those of them at least which resemble beer. But there is a curious exception to this rule in the Koumiss, or milk-beer, made by the Tartars, Arabians, and Turks. This liquor is made from milk, most often from that of mares; it is turned sour and fermented, and afterward so much shaken that the curd and whey become united. It is said to be both pleasant and nutritious, and though it seems so very outlandish to us, an article not dissimilar is prepared in the Orkneys and some parts of the North of Scotland from buttermilk.

What is Porter?

The chief difference between porter and ale is that the former derives a dark color and astringent taste from the use of brown or highly dried malt, and from its having more hops than ale. The origin of this beverage is given by Malone as follows:

"Before the year 1730, the malt liquors in general use in London were ale, beer and two-penny, and it was customary for the drinkers of malt liquors to call for a pint or tankard of half-and-half, and in course of time it became common to call for a tankard of *three-thirds*, meaning a third of ale, a third of beer, and a third of two-penny. To avoid the inconvenience of going to three casks for every draught of ale, a brewer conceived the idea of making a liquor which should partake of the united flavors of ale, beer, and two-penny. He did so, and succeeded, calling it *entire*, or entire butt; and as it was a very healthy and nourishing liquor, suitable for porters and other working people, it obtained the name of *porter*."

What is Spruce-beer?

A name given to a wholesome effervescing beer made from molasses and the extract of the spruce-fir. *Mead* is prepared from honey diluted and fermented. It appears to have been a beverage of great antiquity; it was drunk by the Norsemen, and filled the skullcaps in the hall of Odin; Attila, king of the Huns, died from having partaken of it too freely. By the Saxons it was called meda.

What is Wine?

It is the fermented juice of the grape. This juice, in common with that of most fruits, contains sugar ready formed, and when exposed in summer weather, soon ferments, grows cloudy, however clear it was before, and gives off gas in little bubbles—the process of fermentation proceeds, and in three hours the yeast forms a visible crust on its surface, and pure spirit, or alcohol, is formed.

Where does Wine come from?

The greater portion of the wine imported into England comes from Spain, Portugal, the south of France, Italy, Sicily, and parts of Germany, especially the banks of the Rhine, and the Moselle. Without attempting to describe to you all the varieties of wine, which are very numerous, I may just tell you that the red wine known as Port is the produce of the district of Alto Douro, in the northern part of Portugal, and its name is said to be a corruption of Oporto, from which place it is chiefly exported. Sherry is a white wine, made in the southern part of Spain, and derives its name from Xeres. The wines of Germany are light, acid, brisk, and fragrant, Hock and Moselle being fair examples; while those of the south of France are very fine, Champagne, Burgundy, and Claret being three well known kinds. There are also sweet rich wines made, very different in flavor from any of the above; Malmsey is the most renowned, having originally been brought from Candia; Madeira, brought from the island of that name; Tokay and many others might be mentioned: for these wines the grapes are dried after they are gathered.

A wine is also now made in our country from the Catawba grape, a species unknown in Europe. Extensive vineyards of this grape are cultivated on the Ohio, and the wine made therefrom is rapidly becoming an important article of production and commerce.

Are the grape-vines trained to poles like the hops?

Not where they are grown carefully and well, for though the vineyards look far the most beautiful and picturesque, when the vines are allowed to ramble at will, and hang in festoons from bough to bough; the produce is far greater where they are kept closely pruned and trained to low trellises, as near to the ground as possible. This is of the greatest advantage where the soil is of a loose texture and a dark color, it then absorbs the moisture, so that there is no danger of the bunches becoming mouldy; and it also radiates so much heat during the night, that the grapes nearest to the ground, even when covered by the leaves and shaded from the direct rays of the sun, are often the first to ripen.

How is Wine made?

The process varies for the various kinds; but to give you a general idea I will describe to you the mode adopted in the districts near Bordeaux, which yield the claret. Before the vintage is begun, the fruit must be examined, and none but that which is fully ripe gathered, lest the wine taste raw; though if it hangs too long the wine is injured. The bunches, when gathered, are all picked over, and the unripe and rotten ones turned out; the finest fruit is then put into the principal vat, which is called the *cuve-mère*, or mother-cask; no stalks are put into this vat, but the grapes simply thrown in till they are fifteen or twenty inches deep; two gallons of brandy are then thrown on them, and another layer of grapes filled in with more brandy; this goes on till the vat is full; it is then shut hermetically and covered up close with blankets, in order that no air may reach it; thus it is left to ferment for three weeks or a month, after which it is drawn off clear. During this time the rest of the crop of grapes are being converted into wine, by being picked, trodden in the press, and allowed to ferment spontaneously in the vat, with their stalks and husks among them. After about eight or ten days the wine is sufficiently cooled from its fermentation; it is racked off into clean casks, which have been rinsed with spirits of wine, leaving behind the lees, or *marc*, and the stalks, skins, and seeds which float at the top, and are called the crust, or *chapeau;* the superior liquor from the *cuve-mère* is then divided among the casks, that all may be equal in quality. White wine is not, like the red, fermented in the vat; but, after the grapes have been trodden, the stalks are separated, and the *must*, as the fresh juice is called, is put, with the skins and seeds still in it, into casks to ferment. Long after the wine is made, it needs constant care, frequent racking off into fresh casks, filling up to supply the waste caused by evaporation, and fining, to make it clear and bright.

It is not often finally bunged down till eighteen months old, and even then requires moving into fresh casks at intervals.

I suppose white wine is made from white grapes, and red wine from the dark-colored ones?

No; this does not at all appear to be the case, except that a rather uncommon wine, called White Port, is always made from white grapes. Champagne, which is white, is produced from red grapes, and both white and red are used indiscriminately to make sherry. The coloring matter exists wholly in the skins of the grapes, and if they are taken out of the liquor before fermentation has proceeded very far, no color is imparted.

You told me such a strange list of materials of which Beer was made; is Wine ever made from any fruit beside the grape?

Yes, common wines are made in this country from gooseberries, currants, oranges, lemons, and elderberries, and they used in the days of our grandmothers, who were much more skilled in various culinary arts than their daughters of the present day, to form a very important branch of domestic cookery. Wine is also made in India, in the Moluccas, Philippines, and many other parts of the east, from the sap of the *spadix*, or flower-shoot, of the gommuti palm; the cocoa palm, *Cocos nucifera*, yields another species of palm wine called in India *toddy*; the fan-palm, and the beautiful *Caryota urens*, the most elegant of the palm tribe, are used for this purpose, the latter sometimes yielding a hundred pints of toddy in twenty-four hours. In Africa the sap of the date-palm is most frequently used, and this is said, when fresh, to taste like delicious milk; but, after standing a night or more, and fermenting, it acquires the brilliancy and flavor of champagne. In Mexico a similar drink is prepared from the juice which flows from the flower-stems of the American aloe, *Agave Americana*, after they have been wounded. This beverage is called *pulque*, and is cool and refreshing to the taste, but has a most abominable odor, like that of putrid

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meat; this smell is produced by the fermentation, as the fresh juice is scentless. Cider may also be called a variety of wine, when so wide a circle of the fermented liquors used in various parts of the world is included under that name.

What is Cider?

Cider is the fermented juice of the apple. In portions of the country large orchards of apple-trees are cultivated for the purpose of making cider, and render these parts of the country very beautiful at the time when the trees are in blossom. The apples are usually allowed to fall when they are ripe, or they are knocked down with poles; they are collected into heaps and left for about a month to grow mellow; they are then carried to the mill, which consists of a circular stone trough, usually about eighteen feet in diameter, called a chase, in which the runner, a heavy circular stone, is turned by one or two horses. The grinding continues till the apples are reduced to an even pulp and the pips are broken; a few pailfuls are then put in a hair cloth, under a screw press; other cloths, with must in them, are piled on the first one; thick boards are put over, and the pressure is slowly applied; a thick brown juice exudes from the cloths, leaving only a dry residuum. The cider runs away from the press into a flat tub called a *trin*, and from this it is removed in buckets into casks where there is a free circulation of air. In about three or four days, the time being dependent on the heat of the weather, the liquor ferments, the thick impurities sink to the bottom, and the rest becomes bright clear cider. It is then ready to be racked.

Are Pears ever used to make Cider?

Not exactly, for though they are made into a fermented liquor greatly resembling cider, it is called *perry*.

What is Brandy?

Brandy is the spirituous portion of wine separated from the watery particles, the coloring matter, etc. The word brandy is of German origin, brannt wein, signifying burnt wine, or wine subjected to the fire (that is, distilled). Brandy is distilled not only from both white and red wine, but from marc, which is the refuse of the last pressing of the grapes; this, however, is inferior, from an acrid oil contained in the skins. Brandy is made in all wine-making countries—that of France is preferred; and that from Cognac, a town in the department of Charente, is superior, from being obtained from the white grape, and fermented in such a manner as not to become impregnated with the bitter oil of the grape-skin.

Wat is Rum?

It is an ardent spirit obtained by distillation from molasses and all the scum and refuse of the sugar-mills. When malt liquors are subjected to distillation, the produce is whiskey; and if juniper berries be added before the distillation takes place, gin or hollands is made, which has a peculiar flavor imparted by these berries. The malt for making whiskey is sometimes dried in the smoke of a peat-fire, which gives it a most odious taste, highly appreciated however by the initiated.

What is Vinegar?

Vinegar is a sour liquid used for flavoring, pickling, and many other purposes; it is made by causing wine or malt liquor to pass through a second fermentation called the *acetous fermentation.* Vinegar may also be made of sugar and water.

What is Arrack?

Arrack is the East Indian name given to all spirituous liquors, but chiefly to that which is distilled from rice, and a vegetable juice from the cocoa-tree called toddy. Arrack is but little known with us, and is seldom used, except occasionally to flavor punch and other compounds.

What is Sack, so frequently alluded to by old authors, especially Shakspeare?

Opinions differ as to the character of this beverage. It was probably a Spanish dry wine, and is by many supposed to be sherry. It was usually drunk hot, with sugar. Its name was derived, it is supposed, from being originally stored in sacks or borachios. It appears to have been a very common beverage with the English of two or three hundred years ago: witness the frequent allusions to it we find in Shakspeare's plays. Sir John Falstaff was an inveterate sack drinker.

About Artificial Light.

What is Light?

It is not known with certainty what light is; by some it is supposed to consist of streams or rays of excessively minute particles, sent off in all directions from luminous bodies; others suppose that luminous bodies cause vibrations or undulations in an ethereal fluid that fills all space, and thus an effect is produced on the eye similar to that produced by sound on the ear, which is known to be the result of invisible undulations formed by sonorous bodies.

What is Flame?

Flame is matter that has been volatilized or converted into vapor, and rendered luminous by intense heat. The flame of a common lamp or candle is produced as follows: the oil or melted tallow rises between the fibres of the wick by capillary attraction, and the wick being ignited, the oil is heated to a state of vapor, which then inflames; the oil first raised is dissipated by combustion, other portions are attracted up the fibres, become vapor, are burned likewise, and in this way a constant and steady combustion is maintained. The flame of a lamp is hollow, and not solid; the heated vapor must combine with oxygen before combustion can ensue; hence, only those portions that come in contact with the air are transformed into flame; the vapor that rises from the wick in the centre, rises unburned. The hollow part of the flame is indicated by the darker and less luminous portion seen just above the wick.

How are Candles made?

There are two kinds of candles, *dips* and *moulds*, whose names refer to the manner of their manufacture. The dips, which are the simplest and probably were the earliest candles, are made by dipping a number of twisted cotton wicks, suspended from a rod, into a vat of melted tallow, and hanging them up to cool, this being repeated till the candles are the required size; in many manufactories this operation is performed by machinery, the quantity of tallow being regulated by a counterweight attached to the beam which dips the candles. Mould candles are made in cylindrical pewter moulds, tapering to a small hole at the bottom, the top of the candle being the lowest part of the mould; the number of moulds which are intended to be filled at once are placed together in a trough, and the wicks are fastened in the centre of the moulds by means of a wire inserted into the loop pushed through the small hole at the bottom.

Are not candles made of many other substances besides tallow?

Yes; they are often made of bleached wax; of spermaceti; or of stearine, which is the *fatty* part of tallow separated from the *oily;* there are also composite candles made of purified tallow and wax; palm-oil and cocoa-nut-oil candles, made of the more solid parts of these oils separated from the liquid by pressure.

What is Wax?

The secretion of certain insects, of which the bee is the most remarkable. The wax of the bee is elaborated in its stomach. With his tongue he sucks the saccharine juice in the nectaries of flowers; and this is transformed into wax by certain secreting organs in the animal. The wax then exudes through apertures between the abdominal rings into what have been termed wax-pockets. From the observations of Huber, it appears that sugar is essential to the formation of wax; and that bees supplied with sugar only, and shut up in the house, manufacture wax in the same manner as those bees which are free.

To procure the wax from the combs, after separating the honey from the combs as much as possible, the wax is boiled, pressed in bags, again boiled, and afterward slowly cooled in the air.

What is Spermaceti?

A substance obtained from the head of the Spermaceti Whale, *Physeter macrocephalus*, it is found in a large unctuous mass, and being drained from the oil—*sperm oil*, which is used for burning—and purified, it becomes hard, white, and crystalline. It is used in medicine for various ointments and plasters; but the greatest quantity is employed in candle-making.

What other oils beside sperm oil are employed for burning in lamps?

Train oil, which is the cheapest and commonest, and is obtained from the blubber of the common whale; this blubber is a casing of fat, lying just under the skin, about six inches thick all over the body, and three or four feet thick near the under lip. Extensive whale fisheries are carried on in both the Pacific and Southern Oceans, for the purpose of obtaining this blubber, which is boiled down into oil.* Olive oil was used for lighting in former days, but is not much employed now; its place being supplied by colza, or rape-seed oil, which we chiefly obtain from France.

Is any other substance beside oil used to burn in lamps?

Yes; there are several kinds of spirits employed, of these *camphene* is the most common; it is redistilled spirit of turpentine, freed by that process from all resinous matter, and from much of its unpleasant smell.

How is Gas made?

Coal is heated red-hot in a large cast-iron tube, or *retort*, placed lengthwise in a furnace; the volatile matters given off are conducted by pipes to a receiver, called the hydraulic main, where the liquid products, ammoniacal liquor and gas-tar, are separated from the gaseous ones; the gas is then purified by being conveyed, first through cold iron pipes where some of its impurities condense, and afterward through lime; it is then in some cases washed with water, and finally passes to the gasometer, whence it is distributed by pipes as may be required.

How was gas discovered?

Although the application of it to producing artificial light is a modern invention, yet the germ of the discovery may be traced back nearly two hundred years. In 1669, Thomas Shirley attributed the burning well at Wigan to coal-beds lying under it; and soon after a Mr. Clayton procured gas by distilling coal. His account of his experiments, read before the Royal Society, England, is very graphic and amusing:—

"Having seen a ditch within two miles of Wigan, in Lancashire, wherein the water would seemingly burn like brandy, the flame of which was so fierce that several strangers have boiled eggs over it; the people thereabouts affirmed, indeed, that about thirty years ago it would have boiled a piece of beef, and that whereas much rain formerly made it burn fiercer, now after rain it will scarcely burn at all. It was after a long-continued season of rain that I came to see the place and make some experiments, and found accordingly that a lighted paper though it were waved all over the ditch the water would not take fire. I then hired a person to make a dam in the ditch and fling out the water in order to try whether the steam which arose out of the ditch would then take fire, but found it would not. I still, however, pursued my experiments, and made him dig deeper; and when he had dug about the depth of half a yard we found a shelly coal, and the candle being then put down into the hole the air catched fire and continued burning. I got some coal and distilled it in a retort in an open fire. At first there came only phlegm, (ammoniacal liquor,) afterward a black oil, [tar,] and then, likewise, a spirit arose, which I could no ways condense, but it forced my lute and broke my glasses. Once when it had forced my lute, coming close thereto in order to try to repair it, I observed that the spirit which issued out caught fire at the flame of the candle, and continued burning with violence as it issued out in a stream, which I blew out and lighted again several times, though you could not discern what fed the flame. * * * I then had a mind to try if I could save any of this spirit. * * * I kept this spirit in bladders a considerable time, and endeavored several ways to condense it, but in vain; and when I had a mind to divert strangers or friends I have frequently taken one of these bladders and pricked a hole therein with a pin, and compressing gently the bladder near the flame of a candle till it once took fire, it would then continue flaming until all the spirit was compressed out of the bladder, which was the more surprising because no one could discern any difference in appearance between these bladders and those filled with common air."

This letter was probably written about the year 1688.

When was gas first applied to practical purposes?

In 1792, by a Mr. Murdoch, an English engineer residing in Cornwall; but it was on a very limited scale, and did not attract much attention. In 1802 a large factory at Birmingham was illuminated with gas at the public rejoicing for the peace of Amiens; hundreds of people came to see the sight, and the novelty so far gained a footing that gas-works were established at Birmingham, Manchester, and Halifax. The first part of the city of London where gas was used for street lighting was one side of Pall Mall.

What was the earliest mode of obtaining artificial light?

Torches were used for this purpose; either made of splinters of resinous wood, or long poles with iron ends wrapped round with linen rags dipped from time to time in a vessel of oil carried by the torch-bearer. These, probably, were used for all purposes of out-door lighting from the days of Abraham, for thousands of years, the later Romans using similar contrivances to light their processions.

What were the earliest in-door lights?

For many centuries no in-door light, beyond the blazing wood-fire, would be needed; and, when the necessity was felt, it was supplied by lamps either of metal or clay, formed like bowls or urns, with a small opening at the top for the admission of a linen wick; the Roman lamps differed from these more primitive ones, in the wick being held by one or more *beaks* which projected at the side; hence they formed the model for our common earthen teapots, the spout representing the classic beak.

What were the golden candlesticks which were in Solomon's temple?

These and other ancient candelabra were probably stands which contained, or to which were attached, small lamps for burning oil; the forms of these candelabra were almost infinitely varied, the simplest being a slight rod of brass or some other metal standing on a tripod foot, and terminating either in a flat dish or a cup; others represented trunks of trees, the branches rudely lopped off; others were branched, and bore several lamps (of this kind were Solomon's); and some have been found among Roman remains representing a figure holding the lamp in its hand.

What was the next step in the art of lighting?

Making candles from wax or from solid animal fat called tallow; one of the early records of candles is that which states that Alfred the Great burned a graduated candle for a measure of time; and because the wind that found its way through the walls of his palace made his candle burn irregularly, he invented the horn lantern to shelter it.

What makes these Lucifer Matches take fire when I strike them against the rough box?

The matches are made of little strips of wood dipped in an inflammable compound of phosphorus and nitre, or chlorate of potash. The general principle on which their ignition depends is, that such substances as phosphorus, which have a strong affinity for oxygen gas, and take fire when they come in contact with it, are mixed with nitre or chlorate of potash, which are characterized by a large portion of oxygen contained in a small compass; and then the slightest cause is sufficient to produce a combination of these elements, and combustion.

What is Phosphorus?

A substance of a light amber color and semitransparent; when kept some time, it becomes opaque externally, and looks like white wax. It cannot be dissolved in water, can be cut with a knife, or twisted to pieces with the fingers, when it is exposed to the air it emits a white smoke, and it is luminous in the dark. It burns at a low temperature and with a bright flame. Phosphorus is a substance which, in some of its forms, is very widely distributed. Thus in the mineral kingdom we have phosphates of lead, of iron, of lime, etc.; in the animal kingdom it exists in almost every part of the living frame; and it is to the presence of this substance in an unusual degree, in the countless medusæ and other small inhabitants of the ocean, that we attribute that most beautiful and marvellous phenomenon, the luminous sea. In tropical climates this light is sometimes sufficiently brilliant to light up the smallest portions of the vessel and rigging, the whole expanse of water appearing a sheet of fire breaking into waves of liquid flame.

How are Lucifer Matches made?

The first process is to cut the splints, which are usually made of pine, and of the best quality, as free from knots as possible. The wood is dried before cutting. Most manufacturers use complicated machines driven by steam-power for this purpose, and they are generally so arranged, by knives fitted in different directions, and having different motions, as to cut a number of splints complete at one operation. The next thing to be done is the preparation of the inflammable materials. These are mixed in a strong solution of glue, or of gum-arabic; the German manufacturers use gum, phosphorus, and nitrate of lead, but the matches thus prepared will not bear our climate, and those made with us are mostly composed of glue, phosphorus, and chlorate of potash, with some other ingredients, which, as well as the proportions, are probably different in each manufactory, and are kept secret. The use of these ingredients is chiefly to lessen the noise and unpleasant smell caused by ignition, and to render the matches harder, and less liable to injury from damp. The glue is soaked in cold water, and afterward melted in a copper vessel heated by a water-bath; when the glue is quite fluid, the phosphorus is added, and kept in motion by a pestle furnished with brushes. The nitre, potash, red powder, or smalt for coloring, are then added. The splints having been prepared, are made hot, and dipped in bundles into melted sulphur; the smallest quantity is sufficient, and, when dry, they are redipped in the igniting material. There are two modes of effecting this—the bundle-dip, and the frame or clamp-dip; in the first the workman takes a bundle of splints in both hands, and, by a peculiar motion, makes the ends of the splints spread out so much that they all become separate, and each receives a portion of the composition. The frames used for the other kind of dipping are composed of a series of separate slips of wood, covered with woollen list at one edge, and at the other scored with little grooves just large enough to hold a splint; these grooves are filled with splints by children; the list-covered edge of the next strip keeps the splints in their place, and a number of these strips of wood are then bound together, and form a frame containing perhaps fifteen hundred matches; these are dipped on a table or dipping-stone, on which the composition is poured to the required depth, and kept fluid by heat applied underneath. In one of the Austrian factories it is said six men working at dipping-stones can dip and hand back the frames to the boy who waits on them with such speed as to dip twenty millions of matches daily. The frames of dipped matches are allowed to dry for an hour or two in the air, and are then placed in a stove heated to eighty or ninety degrees, great care being taken to extinguish any that ignite. Women and children afterward take them from the frames, and place them in boxes.

Is not this very dangerous employment for children?

The people who fill the boxes always have a vessel containing sawdust standing by their side, into which they plunge any match which catches fire, and also water into which they put their hands should they be burnt, the phosphorus burns being of a very painful nature; but there is a greater danger than these attending the work; arising from the poisonous nature of the phosphorus, the vapor of which they constantly inhale, and which so saturates their clothes that at night they shine in the dark, and even their hands and arms will glow; this poisonous vapor causes the loss of their teeth and even of the lower jaw, attended by violent pain. It appears that amorphous phosphorus, a curious modification of the material, caused by subjecting it to intense heat for some time, is no longer poisonous, and emits no fumes, and when this kind is in general use all the difficulty and danger of the process of match-making and match-using will be done away, for it should never be forgotten that every lucifer of the present kind contains enough of phosphorus to make it a dangerous poison.

There must be a great many matches made?

The number is enormous. English statisticians state that over two hundred millions are consumed in that country every day; a single saw-mill near London cuts up annually four hundred large timber trees into splints for matches, and another buys thirty and forty thousand dollars' worth of pine at a time for the same purpose.

What was used to obtain a light before the invention of Lucifer Matches?

The invention which was in common use was the flint and steel, with its accompanying tinder-box; and even now in some remote places may be found aged females, whose horror of the new lucifers cannot be overcome, and who perseveringly adhere to this most tedious plan, which has sometimes to be tried and tried in vain till patience hardly holds out. The flint and steel were certainly known to the Romans; and were used by our Saxon ancestors, who called the apparatus "Fyr-stan." The only earlier means of obtaining fire of which we know, is that of rubbing two dry sticks together, or of making a hole in one dry branch of a tree and rapidly turning another pointed piece of wood in the hole till the friction produced a spark; one or other of these plans is still pursued by all uncivilized nations. The inconvenience of the flint and steel induced many attempts to produce fire by some chemical process. There was the platina lamp, by which a stream ot hydrogen gas was directed against a mass of finely divided platina, which possessed the singular property of setting it on fire. Then there was the chemical match, the tip of which was supplied with a paste of sulphur and chlorate of potash, and which took fire when brought in contact with sulphuric acid, which was usually kept in a bottle filled with asbestos, and the matches touched with the stopper, which sufficed to ignite them. After these came Prometheans, which worked on the same principle; they were little glass beads filled with sulphuric acid, surrounded with a little inflammable paste, and rolled up in paper, these were crushed with a pair of pliers. The friction-match was an old-fashioned sulphur-match coated with an inflammable mixture containing sulphuret of antimony, and was lighted by drawing it quickly through a piece of folded sand-paper. The next improvement was to replace the antimony by phosphorus, and this was the precursor of lucifers such as we now use.

What is the Drummond Light?

This light arises from exposing a globule or pea of lime to ignition in a blowpipe, consuming oxygen and hydrogen gases, which are directed upon the ball or disc of lime from separate vessels or gasometers through a flame arising from alcohol. It was invented by Captain Drummond, and was first used in the Ordnance Survey of Ireland. It is probably the most powerful light known, and can be seen a distance of thirty miles. It is now much used for light-houses.

About Sugar.

What is Sugar?

It is a sweet crystallized substance obtained from the juice of the sugar-cane, *Saccharum officinarum*, a reed-like plant, growing in most hot climates, but supposed to be originally a native of the east, whence it was brought to Europe by the Moors; it was cultivated by them, and afterward by the Spaniards, Portuguese, and Sicilians, in the southern parts of he peninsula, and in Sicily and some adjacent parts. The islands of the Atlantic, the Azores, Madeiras, Canaries, and Cape Verd Islands, were its next resting-place in its westward march; and from these it was transplanted to the West Indies and Brazil, when those fertile lands were discovered and appropriated by the Spaniards and Portuguese. The latter nation long supplied the greater part of the markets of Europe with sugar, at a less price than that obtained from the East Indies.

What is the Sugar-Cane like?

The root is jointed and sends up several stems which are also jointed, and which rise to a height varying, with the nature of the soil, of from eight or ten to twenty feet; a leaf, three r four feet long, springs from each joint; the flowers, which are whitish and enveloped in long down, grow in bunches at the top of the cane. The general mode of cultivation is to set out a portion of the plantation each year with cuttings, to form fresh plants, but over the rest of the ground to leave the old roots in; from these fresh canes shoot up, which are very good the first year or two, but are apt to degenerate. Great care is needed to hoe the cane-field, and keep it free from weeds, and the soil, unless naturally very rich, must be supplied with abundant manure, if a heavy crop is desired. When the canes are ready, which is generally in February, March, and April, they are cut down close to the root, the leaves are stripped, the stalks divided into convenient lengths, and taken at once to the *crushing mill;* here they are squeezed between iron rollers, and the expressed juice flows, after passing through a strainer, into large clarifying vessels, where a portion of lime is added to purify it. It is next heated very hot, which causes a great deal of thick sediment to fall to the bottom of the pan, and a scum rises; the clear juice is drawn off and conveyed to the large evaporating pan; in this it is boiled down to a much smaller quantity; it is afterward removed to other smaller pans to be boiled again and again. All this is done with great expedition, as in a tropical climate the juice would very quickly ferment. During the whole time that it is boiling it must be skimmed, and the scum thus obtained, with all the other impurities separated in the process, are set aside for the purpose of making *rum.*

When the juice is sufficiently boiled down, it is removed into a copper cooler, and from this into a very shallow wooden vessel, in which it crystallizes. After the lapse of a few hours, the dark-looking mass, consisting of sugar and liquid molasses, (that part of the juice which will not crystallize,) is put into hogsheads with holes bored in the bottom; these are set on a wooden frame over a cistern, into which the molasses drains; when this has gone on for a sufficient length of time, the hogsheads are filled up, headed in, and are ready for exportation.

Is this all that is done to Sugar?

This is all the process needful to make common brown sugar, or as it is often called *raw* sugar, because it is not boiled any more; for the finer white sugar, known as loaf or lump sugar, it must be dissolved again, and subjected to various filtering and clarifying processes, which remove all the impurities, and render it white, though its sweetening property is somewhat lessened by the operation. When it is quite ready for re-crystallization it is poured into conical moulds, each of which has a plug filling up a hole at its apex, this plug is removed after the sugar has been poured out a day; the moulds are arranged in a framework, with a jar below each, into which the syrup drains. When sufficiently dry, the sugar is scraped, and the scrapings are placed on the top of the mould, while a portion of the finest syrup is poured upon the mass, which gradually drains through, taking a great deal of the dark-colored syrup with it; this process is repeated till the syrup which drops through is quite white. After several days standing to harden, the loaf is turned out, and the point, which is still rather discolored, is shaved off, this causing the well-known *sugar-loaf-form*, instead of the perfect cone *made by the mould.*

What is Sugar-Candy?

It is merely a slightly different preparation of sugar; a reboiled solution of it, which, when removed to a hot room, forms large crystals upon strings or sticks put into the vessel for that purpose.

Is Sugar ever made from any thing else than the sugar-cane?

Yes; it is made from the juice of the sugar-maple, *Acer saccharinum*, a fine-looking forest tree, which grows in most of the Northern states of the Union. It is usual with the settlers, when clearing their land, to leave a few maple-trees for the home supply of sugar; but there are also large tracts of maple forest still undisturbed, from which abundant stores of this delicious sugar are obtained. The syrup is collected in March and April, when the sap begins to rise, the most favorable weather being frosty nights and sunny days. A hole is bored in the trunk of the tree, and a small chip inserted, from off which the sap runs into a trough placed below; from these troughs it is collected once or twice in the day, and boiled down to the crystallizing point in an iron pot, which is often supported in the rudest manner upon sticks, as the manufacture is generally carried on close to the trees, sugar-making being performed at a sort of pic-nic, or "bee," as it is called, the party residing temporarily in a shanty built in the forest.

Is Maple-Sugar as good as Cane-Sugar?

When refined they are hardly to be distinguished from each other; but for domestic use the settlers prefer their maple sugar of a dark-brown color and with a strong, peculiar flavor. The uncrystallizable part of the sugar, called "maple honey," is extremely pleasant to the taste, and is considered quite a luxury. In India and some other parts of Asia, a kind of sugar called *jaggery* is obtained from various species of palm-trees. The sweet juice from which it is made flows from the top shoot or spadix of the tree when it is wounded.

I have heard of Beet-root Sugar—what is it?

It is a kind of sugar largely made on the Continent of Europe from the root of the beet. This manufacture had its rise in the exclusive continental system of Napoleon, who would not allow any foreign products to be used, and by taxes raised the price of cane sugar to five shillings (six francs) a pound. Under the protection of this duty the manufacture of beet-root sugar was brought to a flourishing condition, after surmounting, by the aid of science, many difficulties; and though the causes which led to its establishment have long ceased to act, it still continues profitably to employ large numbers of the population of France, Germany, and Russia.

There must be a great deal of sugar consumed in the world.

Yes, indeed, there is; the produce of cane sugar alone has been estimated at four thousand five hundred and twenty-seven millions of pounds, and the quantity seems to increase. In ancient times honey was the chief sweet which was employed, and "a land flowing with milk and honey," is the Scripture expression for a land possessing all the luxuries of life. Sweet substances were also extracted from the grape and other fruits, many of which contain a large proportion of a kind of sugar, differing slightly from the cane sugar but resembling it in all essential particulars; this you will readily believe, if you think of the white sugary crystals you have often seen in raisins which were a little too much dried. There is reason to suppose that long before the art of preparing sugar from the sugar-cane was known, pieces of the cane itself were brought to table and the fresh juice sucked out; but all these sources could have yielded a very small proportion of the quantity at present consumed, which renders sugar the staple produce of the West India Islands, Brazil, and other parts of South America, Java, Mauritius, Bengal, and some other places. Hundreds of thousands, nay, perhaps millions of men, live by cultivating and manufacturing it.

You spoke of Honey as a kind of sugar, did you not?

I spoke of it as a sweet substance used instead of sugar formerly; but it is really a sugar secreted in the nectaries of flowers, collected by the busy bees, and stored away in their beautiful hexagonal cells, the construction of which, and the whole economy of the hive, are among the most curious and admirable results of that unerring instinct which the great Creator has bestowed on the lower animals for their guidance and protection.

I never thought of honey as sugar before; it crystallizes like sugar, I know, because old honey is quite thick, and not transparent as fresh honey is.

There are many foreign particles in the honey collected from different flowers, which causes it to vary in color, flavor, and quality; where the flowers are very sweet and fragrant, the honey is highly prized; such was the honey brought from Mount Ida, in Crete, the honey of Hymettus and Hybla, the beautiful Narbonne honey, and that of Chamouny, while in Scotland the heather, when in full bloom, scents the honey of the bees which are kept in its neighborhood. In some cases poisonous or narcotic flowers impart their properties to the honey extracted from them to such an extent as to render it very dangerous to eat.

What is Treacle?

I thought you would understand when I was describing the manufacture of sugar, that the thick, uncrystallizable, brown liquor which flows from the sugar, and which is so often spoken of as molasses, is the same thing as treacle.

About Paper.

Of what is Paper made?

Chiefly of linen and cotton; white linen rags used to be considered the only material of which the finer kinds could be made; but cotton rags and waste refuse cotton are now used, and the improvements in bleaching are so great that for many purposes it is quite immaterial what color the rags are. This country cannot supply any thing like a sufficiency of rags to meet the demand for paper, and large quantities are imported from Russia, Italy, and other parts of Europe. Hemp, old ropes, and even straw, are employed for making rougher and inferior kinds of paper; and the attention of the scientific world has been turned to finding some new cheap material, which may answer the purpose as well as linen or cotton rags, and be abundant enough to supply the ever-increasing demand for paper.

How is Paper made?

When rags are to be converted into paper, the first process is, to sort them thoroughly and cut them into small pieces; they are then well washed, either in hot water in the fulling-mill, or they are subjected for several hours to the action of steam. They are rinsed by being placed in a vessel in which a wheel or cylinder revolves, which gives them a slow progressive motion; and a stream of clear water is allowed to flow through the vessel, which is continued till the water flows out as clean and clear as it entered. The rags are bleached with chlorine, either in the form of gas or in combination with lime as chloride of lime. Reducing the rags to pulp is effected by subjecting them to the action of a revolving cylinder supplied with sharp cutters, or teeth, which tear the rags and drive them upon other cutters fixed underneath the cylinder. The material, whatever it was, of which the paper was designed to be made, is now brought to a perfectly white, even, soft, and very thin pulp; it is *blued*, and, if intended for printing on, is often mixed with size; writing paper is not sized till it is in sheets.

How can this thin, wet stuff ever become firm, smooth, glossy sheets of paper?

There are two modes of manufacture, one by hand, the other by a machine. It will be best to explain the first mode to you, as the latter can scarcely be understood unless the machine is seen in operation. The pulp, which is placed in a large vat, kept slightly warm, is continuously kept in motion, that the fibrous particles may not settle. The workman, who stands by the side of the vat, takes up a portion of this pulp on a *mould*, which is a shallow frame made of fine wire-cloth, a little larger than the sheet of paper to be made, and he carefully holds it horizontally that the sheet may be the same thickness all over. The vat-man sets the mould and paper to drain on the edge of the vat, and proceeds to make another sheet; meanwhile another workman, called a *coucher*, deposits the wet sheet on a piece of felt and returns the mould;

they proceed in this manner till a great pile of sheets and felt is made, which is then taken all together to the vat-press and subjected to very strong pressure, to squeeze out the water and make the paper firm. When it comes out of this press the felts are removed and the paper is pressed again by itself. This completes the process for making the paper; and all the finishing processes are chiefly used for writing-paper, that intended for packing or for printing being considered finished when dried and pressed.

How is Writing-paper finished off?

Several sheets at a time are dipped into liquid size, and then they are pressed in a very strong press; they are afterward separated, piled together again, and again pressed, and this is done several times to make the surfaces quite smooth.

What is Size?

It is a kind of very thin glue made from skins, horns, etc.; it is necessary to put it on the paper to prevent the ink from running; blotting-paper is not sized at all, and all printing and other papers, except writing-paper, are usually sized in the state of pulp.

Now tell me about the machine for making Paper?

This machine, which was invented by Mr. Fourdrinier, is one of the most perfect and beautiful contrivances in machinery, and yet is very simple. The pulp flows from the vat in an even stream over a ledge, on to a web of wire gauze, the width of a sheet, and five or six feet long; the web is moved forward, by which means the quantity of pulp and the consequent thickness of the paper are regulated, the water falls through the wire, and, by the time the pulp reaches the end of it, it has ceased to be fluid; it passes next to an inclined plane of felt, which further dries it, and delivers it to a pair of rollers, between which it is squeezed; on it goes to more felt and another pair of pressing-rollers; now it is paper, but all rough, and still damp: the machinery carries it on over polished cylinders, and made very hot by steam, and then, after being further pressed, it is wound up, finished, and ready to be cut into sheets for use. If it is to be sized after it is made, it passes through a bath of size before it goes over the latter hot rollers, and is thus dipped and dried without the least trouble. It is a curious sight to see the wet pulp flowing in at one end of the machine, and after a few minutes delivered at the other end in the form of finished paper.

How long ago was Paper invented?

The Chinese, who have so often been the first to discover any useful invention, appear to have been the first papermakers; they claim to have made it as early as the first century after the Christian era. Much of their paper is by some supposed to be made of refuse silk, while others maintain that silk alone is not capable of being reduced to a pulp suitable for making paper; they certainly use a large portion of the inner bark of the bamboo, which is well suited to the purpose, and is probably, in most instances, mixed with the silk; they also make common paper of rice straw, as well as of both cotton and linen rags.

How did Chinese paper first become known in Europe?

The art appears to have travelled as far west as Samarcand, where there was a manufactory of paper, and when the Saracens captured the place in the seventh century, they acquired the secret, which with so many other useful arts they brought with them to Spain. In that country, however, they found linen a cheaper and better material than any that had been used before, and they established a large factory for making paper of that material at Xativa, now called San Felipe, in Valencia. This Moorish paper was well known in the twelfth century, though the entire invention of the art has sometimes been attributed to the Italians, and dated at the middle of the fourteenth century.

When was paper first made in England?

A paper-mill was set up at Hertford early in the sixteenth century, by a man named Tate, and Queen Elizabeth knighted a German who had a mill at Dartford in Kent, in 1588. But the paper manufacture made slow progress, and till a much later period most of the paper used in England was imported from France or Holland. Fuller gives a humorous account of the different kinds of paper in use in his time. "Paper," he says, "participates in some sort of the character of the country which makes it; the Venetian being neat, subtle, and court-like; the French light, slight, and slender; and the Dutch thick, corpulent, and gross, sucking up the ink with the sponginess thereof."

What was used for writing on before the invention of paper?

Many devices were had recourse to, inscriptions were engraved on the rock, and the letters filled up with lead; they were also cut on smooth, prepared tablets of stone, of which kind were the tables given to Moses, containing the Ten Commandments. The Assyrians and Babylonians stamped the impress of their letters upon unbaked bricks and cylinders of clay, which were afterward baked and made so durable, that modern research has enabled us to read in their own words, the accounts which the heroes of those ancient times wrote of their wars with the Hebrews. Thin wooden boards covered with a coating of wax, or some similar composition, were employed among the Greeks and Romans; they were written upon with a metal style, and possessed this advantage, that the writing could be effaced when no longer needed. Plates of metal and thin sheets of ivory were also employed, and the skins of animals, either in the form of parchment, or in a less prepared state. The leaves of trees were used, as those of the talipot-tree are still in some parts of the east; and above all, the *papyrus*, or paper-reed of Egypt, superseded all other materials wherever it could be obtained.

What was this Papyrus—how was it made ready for use?

The papyrus, which is by some botanists called the *Cyperus papyrus*, and by others the *Papyrus antiquorum*, is a tall reed, formerly very common in Egypt, Syria, and Abyssinia, and other adjacent countries; it grows in both stagnant and running water, has a stem from three to six feet high, with three acute angles, one of which always faces the current, when it grows in streams, as if to break the force of the water. The roots are sometimes employed as food, and the flower-stems are twisted into ropes. In order to prepare it for use as a writing-material, the thin concentric coats which surround the stem were stripped off and cut into strips of a certain length, generally from ten to thirteen fingers' breadth; several of these strips were placed side by side on a board, and another layer pasted crosswise on them—the sheet thus formed was afterward pressed and dried, and then polished by rubbing with a smooth shell or some similar substance.

Were these little sheets used separately?

No; a number of them were generally glued together by their edge, to form a roll, or *scapus*, as it was called; often not more than twenty of the sheets were used to form the roll, but it could be produced to any extent, and some have been found as much as thirty feet long. In the Egyptian papyri (which term is applied quite as much to the written scrolls as to the reeds which furnished them), the writing is always in columns, with blank spaces left between, and the position of the initial letters and other things show, even to the unlearned observer, that the writing was from right to left, or the reverse of our mode. Some of these Egyptian papyri were written in what were called *enchorial*, or common writing, and some in the hieroglyphic, or picture writing.

Did other nations beside the Egyptians use these Papyri?

Yes; Herodotus states that the Papyrus was an article of commerce long before his time, and for many centuries it was a very important branch of the exports of Egypt; the great number of Papyri found among the ruins at Herculaneum prove how commonly it was used in Italy, and it continued to be the principal substance employed for writing on in that country, until superseded by *cotton* paper brought from Asia. Herodotus calls the papyrus *byblos*, from the Egyptian name for the plant, and it is probable that the Greek word *biblion*, a book, has been derived from this word; and thus we trace back the name of our English *bible* to the plant which furnished the material on which it is probable that Moses wrote, and from which he read "all the learning of the Egyptians."

Is not our word paper derived from papyrus?

Yes; the word paper and also the name for it in all the modern European languages, except Russian and Italian, are thus derived. The Italian *carta* comes from the Latin *charta*, which was applied as well to parchment, and all other materials for writing upon.

You speak of parchment as the only substance now used beside paper, for the purpose of writing on—what is it?

Parchment is made of skins of sheep and lambs, though that kind which is used for the heads of drums is said to be made of goat-skins. Vellum is a finer, smoother, white kind of parchment, made of the skins of young calves. The mode of preparation is first to take off the hair or wool, then to steep the skin in lime, and afterward to stretch it very firmly on a wooden frame. When thus fixed, it is scraped with a blunt iron tool, wetted, and rubbed with chalk and pumice-stone, and these scrapings and rubbings are repeated several times on each side of the skin till it is fit for use. Parchment was employed in very ancient times, and it is curious that from about the seventh to the tenth century, it was beautiful, white, and good, but that in later times a very inferior, dirty-looking kind of parchment came into use, which has the appearance of being much older than the good. The reason for this is supposed to be, that the writers in these later centuries used to prepare their own parchment, while at an earlier date it was a curious art only possessed by the manufacturers. Parchment was sometimes so rare and scarce that great numbers of the older manuscripts were erased with pumice-stone, or the ink washed out with some chemical substance, in order that they might be used again for writing upon.

Why is the paper which is used to cover the walls of rooms called Paper-Hangings?

Years ago, as you already know, beautiful embroidery was used to hang round the walls of rooms, to make them look warm and comfortable. This work, which was called *tapestry*, was in most cases the amusement of rich ladies, who had not much other employment either for their minds or their hands, in a time when education was so little attended to. Matilda, the queen of William the Conqueror, assisted by the ladies of her court, worked a piece of tapestry, known now as the Bayeux tapestry, which describes in a number of scenes all the principal events connected with her husband's conquest of England. Other materials beside needle-work came to be employed for hangings on the walls, such as silk, velvet, and even fancy work of feathers. When paper began to be common in England, attempts were made to supply the place of these costly hangings by the cheaper material, and as they were *hung* up, so the paper was said to be hung, and called hangings, even though convenience caused it to be pasted to the walls instead of merely hung up before them.

What is Card-board?

Card or paste board, in all its varieties, from the finest drawing-board to coarse, stout mill-board, is made by pasting together sheets of paper, and afterward subjecting them to pressure; so firm and hard can this be made that, in one instance, a paper manufacturer roofed a part of his mill with stout board made of brown paper. There is another similar substance, similar at least so far as its construction is concerned, though in external appearance very different—I mean *papier maché*, of which are made trays, work-boxes, etc.

Is Papier-Maché made of paper?

Yes, it is made in the same manner as mill-board; a coarse, thick kind of paper of a grayish hue is used for this purpose, and the sheets are pasted over a mould the form of the article intended to be made. When the rough *papier-maché* is dry, it is firm enough to be finished off by planing or turning in a lathe, just in the same manner as if it were wood. The surface is generally highly polished and ornamented with gilding, or with painting, in which manner beautiful groups of flowers, or animals, or even copies of good pictures by famous masters, are transferred to our trays and writing-cases, screens, and boxes; thus forming a new and very attractive application of art to our household uses. Another mode of ornamenting *papier-maché* is, that of inlaying it with pearl. When this is intended to be done, the pearl, which is very thin, is cut out the shape intended, and attached by cement to the surface of the *papier maché*; any coloring or gilding which is desired is then applied, and afterward the whole surface is covered with a thick transparent varnish, which raises it all to the level of the pearl.

What is Tracing-paper?

Tracing-paper is made of the refuse of the flax-mills, and being formed into a semitransparent stuff, yields a transparent paper. The same material is used for the paper of bank-notes; but for this latter purpose it is bleached with chlorinated lime.

What is Rice-paper?

A substance said to be made from a membrane of the *Artocarpus incisa*, or bread-fruit tree. It is brought from China in small pieces, dyed of various colors, and is used as a material for painting upon, and for the manufacture of fancy and ornamental articles. It was at first erroneously supposed to be prepared from rice, hence its name.

Why is the term "Foolscap" applied to the paper so designated?

It is said that this designation is derived from the fact that Charles I. granted to certain parties a monopoly of the manufacture of paper, and every sheet bore in water-marks the royal arms. But the Parliament, under Cromwell, made jests of this in every conceivable manner, and ordered the royal arms to be removed from the paper, and the fool's cap and bells substituted. Of course these were removed after the Restoration, but paper of the size of the Parliament journals always retained the name of "foolscap."

Miscellaneous.

What is Sealing-wax made of?

It is a compound of shell-lac and resin, and is colored with vermillion, lampblack, or verditer, according to the hue desired; these ingredients are melted together, and the sealing-wax is afterward formed into sticks by rolling.

You say it is made of Shell-lac—what is that?

Lac is a resinous substance produced by a little insect, the *Chermes lacca*, on the leaves and branches of certain trees growing in Bengal, Assam, Pegu, and Siam. This little creature lays its eggs on the bark, and then covers them with a quantity of lac, which is evidently intended to protect them in their early stages, and to feed the young larvæ when they come out. It is beautifully formed into cells, with much care and regularity. Lac yields a fine red dye, inferior in color to cochineal, but said to be even more permanent.

You call it lac; in speaking of sealing-wax, you called it shell-lac?

Yes; there are several different kinds of lac, or at least different states in which it is brought to market; first, there is stick-lac, which may be called its natural state, nothing more being done to it than breaking off the incrusted twigs and bringing them to market; seed-lac is the pounded stick-lac after it has been separated from the sticks, and all the coloring matter extracted from it, which makes the lac-dye, or lake. Shell-lac is produced from seed-lac, by melting it, and straining through a bag; it thus forms thin, transparent, amber-colored plates, and is used, as you have heard, for making sealing-wax, and for varnish, also in making hats.

What is the Cochineal you mentioned?

A brilliant red dye, obtained from certain small insects which abound in the tropical parts of America; being found wild in Mexico, Georgia, South Carolina, and some of the West India Islands, feeding on the common Indian fig, or prickly pear, *Cactus opuntia;* in Mexico and some of the adjoining Spanish settlements, the insect is reared with great care on the *Cactus cochinilifer*, on which it grows much larger than in its wild state, though seldom exceeding a barley-corn in size. The female insect alone is gathered, as it alone yields the dye; it is wingless, and very stationary, seldom moving from the part of the plant where it has fixed itself; it spins a little web, lays its eggs, and dies; the male has wings. It may seem strange to speak of a crop of insects; but the growers of cochineal treat it like a crop, and make a very profitable trade of it: their first care is to rear the plantation of prickly pears; and, when this is ready, pieces of a plant infested by the cochineals are placed here and there among the others; they soon spread, and in time the plants are all covered.

How are they collected?

The wild cochineals are gathered six times a year, just before they lay their eggs, but the cultivated only three times. The insects are detached from the plant by means of blunt knives, and are put into bags and dipped into boiling water to kill them; they are afterward dried in the sun, and, though they lose two-thirds of their weight by this process, yet six hundred thousand pounds are annually sent to Europe.

What do the Cochineals look like?

Like small oval grains, flat underneath, dark and dusted over with a white powder; when crushed, they form a rich dark-red powder, and from them all our most beautiful scarlet and crimson dyes are procured.

Are other insects used for dyeing?

Yes, there is the Kermes, an insect of the same species as the cochineal, found upon the evergreen oak; which was much used, before the discovery of America, for dyeing scarlet; its name is of Persian origin, and the Moors appear to have been well acquainted with its use, both before and after their settlement in Spain. Since the introduction of cochineal, it has been little used, as the dye it yields is much darker and less brilliant, though it stands better. The scarlet wools dyed with kermes, in some old tapestries in existence at Brussels, retain all the brilliancy of their color, though they are two hundred years old.

Are all red dyes obtained from insects?

No; one which is commonly used is obtained from logwood, which is brought in blocks, and afterward chipped up into little pieces, in which state the dyers make a decoction of it. The logwood-tree, *Hæmatoxylon Campechianum*, grows in Campeachy, and some other parts of South America and the West India Islands. It is a small tree, seldom more than twenty-four feet high, very crooked in its growth, branching and bushy, and the smaller branches beset with strong spines; it has pinnate leaves, and terminal clusters of reddish-yellow flowers. Another red or pink dye is obtained from the flowers of the dyers' Carthamus, *Carthamus tinctorius*, also called safflower; this is an annual plant, growing in Egypt; it has a stout stem, with many pointed leaves full of strong veins, and a flower not much unlike a rich orange or golden colored thistle, though it is not the same order of plants as the thistle.

What are purple prints dyed with?

With madder, the root of a plant cultivated in many parts of France and in Zealand; that which comes from the Levant is thought superior to any other, and the difference is attributed to the roots of this kind being dried in the open air, under so clear a sky. The beautiful bright red, called Turkey red, is also dyed with madder, the different colors being the result of different mordants which are used. The Latin name of the madder is *Rubia tinctorium.*

What is Indigo?

It is a deep-blue dye, obtained by steeping the leaves of a small leguminous shrub, the *Indigofera tinctoria,* in water; a blue sediment is deposited, which is afterward evaporated to dryness. This dye has been used in India for many ages, but was not known in Europe till the middle ages. One species grows wild in the temperate parts of Asia, and another in tropical America, and in central Africa. The greater part of that now used is, however, the result of cultivation.

Was Dyeing an ancient art?

It is very old; indeed in all ages brilliant colors have excited admiration, and even the uncultivated savage has evinced a passion for the beautiful and bright hues to be found in the feathers of birds and other natural objects. The origin of dyeing, or producing colors by artificial means, is of great antiquity, for Moses speaks of stuffs dyed blue and purple, and scarlet, and of sheep-skins dyed red. Among the Greeks dyeing seems not to have been much practised; the woollen clothes usually worn by them were of the natural color of the sheep; but the wealthy preferred colored dresses, of which scarlet was much esteemed; still purple was more highly valued, and was the distinguishing mark of the greatest dignities, being reserved for princes only. The most famous of their purple dyes was that called Tyrian, which is said to have been extracted from a certain shell-fish, a species of murex, common on the shores of the Mediterranean; but the quantity of purple juice afforded by this animal is exceedingly small, and consequently garments stained with it were of great price. The Romans were equally severe in restricting the use of purple to the highest rank; and it does not appear that the number of their dyes and dyed colors were considerable, although colored dresses were not rare among them. The art of dyeing slowly improved in modern times, until the application of chemistry, by throwing on it peculiar light, has of late advanced it to a degree of perfection formerly unknown; and this has afforded great resources to the ingenuity and industry of man. The superiority of our dyes must be ascribed principally to the employment of pure alum and solution of tin as mordants—substances which give to our common dye-stuffs remarkable depth, durability, and lustre. Another recent improvement is the application to textile fabrics of metallic compounds, such as Prussian blue, chrome yellow, etc.

What is Whalebone?

It is a substance very nearly resembling horn, and is obtained from the upper jaw of the whale; it appears to serve the animal instead of teeth. The pieces of whalebone vary, with the size of the whale, from three to twelve feet in length, and the breadth of the largest is about one foot at the thickest end. Whalebone is extremely elastic, and is used in large quantities in this country for making the ribs of umbrellas and parasols, bones for stays and hoops, which the ladies of the present time wear, as did their fair ancestresses, as far back as the days of Queen Elizabeth. So little was known of the anatomy of the whale in olden times, that there is recorded an old feudal law, by which it is provided that the *tails* of all whales caught belonged to the queen, in order that the royal wardrobe might be supplied with whalebone!

What is Isinglass?

Isinglass is a kind of very fine pure glue, made of the air-bladders and sounds of various large fishes. The best is that brought from Russia, where a great quantity is made from the fish taken in the various large rivers which flow into the North Sea and the Caspian. Isinglass dissolves readily in boiling water, and is used to make jellies, *blanc-mange*, and many other pleasant articles of cookery; it is often used to stiffen silk, to make sticking-plaster, and for various other purposes. A less expensive article of a similar kind, called *gelatine*, has been introduced of later years, but it is not nearly so good as isinglass.

What is real Glue?

It is made of refuse horns, hoofs, parings of hides, and other similar materials, boiled down to a thick jelly, and repeatedly strained from all impurities. When cold it makes hard, thin, brittle cakes, which, when boiled with water, form the strongest material for uniting wood.

What is Bell-metal?

A compound of copper and tin, which becomes not only more sonorous, but heavier than either of the ingredients apart. The proportions differ; ordinarily, however, twenty-three pounds of tin are mixed with one hundred pounds of copper—the latter being somewhat increased when the bells are larger. Brass, spelter, and even lead are sometimes added; and, more rarely, silver, which is considered much to improve the tone of the metal.

What is Ink made of?

There are a great many different kinds of ink, and the ingredients vary very much, but in most fluid writing-inks *galls* and *sulphate of iron* are the chief, with the addition of gum-arabic to render the ink a little adhesive and make it flow properly from the pen. Some very black ink is made with oxide of manganese. A great deal of the best ink is very pale when first written, but turns black, from the absorption of oxygen, with exposure to the air; the ink with which ancient manuscripts were mostly written was not, like ours, a chemical compound, but was made simply of charcoal dust suspended in water with a little gum; the color of this compound must have been much more enduring than that of our inks, but it would be both disagreeable and tedious to use. Red ink derives its color from Brazil-wood, a well-known dye, and blue is colored with Prussian blue.

What is Marking-ink? I know it is not black but gray.

Marking-ink is a gray-colored solution of nitrate of silver and an alkali; it becomes, when properly prepared, a deep indelible black, on exposure to heat and light; and the coloring matter is so intimately connected with the cloth as almost to become a part of the fibre, as is the case in all really permanent dyes.

Are there any more kinds of Ink?

Yes; there is Chinese or Indian ink, and printers' ink; of these the former is more like the old inks that I mentioned to you than those we use now; it is made of the finest lamp-black, carefully prepared, and animal glue; some delicate perfume is usually added to these ingredients, and the whole is made into solid cakes or sticks, which are ornamented with letters or figures, in colors or in gilding. This ink, which is chiefly used in this country for drawing, either with pen or camel's hair pencil, for shading and other similar purposes, is used in China for writing with, which is done with a brush instead of a pen, the roughness of the effect produced being familiar to us all, in the appearance of the characters on the papers in which the tea is wrapped. Printers' ink is composed of lamp-black, turpentine, oil, and resin mixed in certain proportions, and is a glutinous adhesive black paste; it is applied to the type by means of a roller composed of glue and treacle, which passes first over the slab or table supplied with ink, and then over the surface of the type. Several curious and fancy inks have been invented which change color when exposed to heat or light, or which being invisible when written, can be made to appear by the application of some other substance; these are called *sympathetic* inks.

What is Ivory?

Ivory is the substance of the large tusks of the elephant, which grow on either side of its mouth, something like horns in form. Tihs well-known article is much valued for its whiteness, fine grain, and the good polish that it takes, and in the countries where elephants abound, hunting them for their tusks is a very profitable, though perilous and laborious employment.

What countries are these which supply us with Ivory?

The southern coasts of Africa, India, Ceylon, and the countries north of the Malay Peninsula; the Chinese market is chiefly supplied from these latter countries, and from the Islands of Sumatra. The greatest quantity of ivory imported is used for knife-handles, but much also is used for making musical and other instruments, chess-men, billiard-balls, and toys. The Chinese excel all other nations in the art of working and carving ivory; they carve concentric hollow balls of which the inner ones, though only visible through the perforations in those which are outside them, are as perfectly ornamented, and as entirely free to move and turn as the outer ones. The Chinese chess-men, boxes, and card-cases are far superior to any that can be made in Europe. It is generally considered that African ivory retains its whiteness longer than that from the East Indies. Ivory is also obtained from the tusks of the walrus or sea-horse as well as from those of the elephant.

Is there not something called Vegetable Ivory?

Yes; there is a beautiful white substance now often used instead of ivory, which is the kernel of a nut produced by a member of the palm tribe. This most beautiful tree, the *Phytelephas macrocarpa*, grows abundantly on the banks of the river Magdalena, and in some other parts of tropical South America; the fruit, which is large and hard, and is called by the inhabitants *tagua cabesa de negro* (negro's head), contains at first a clear fluid, very pleasant to the thirsty traveller; this fluid becomes more milky, and by degrees slowly solidifies, until at last it is as hard as ivory. This phenomenon of a nut being filled with juice which hardens into a solid kernel, is by no means uncommon among the palm-trees, of which we have a familiar instance in the cocoa-nut; and there are some species beside the tagua whose fruit is suited for carving into ornaments.

What is Coral?

This curious substance, about which so much uncertainty was felt, has been proved to be the habitation and work of numerous small creatures very far down in the scale of creation, almost at the lowest point of animal life, where it insensibly melts into the lower forms of vegetation; yet these little *polypes*, as they are called, have a large vocation assigned to them in the economy of nature; not only do they form the beautiful white coral so often seen adorning our cabinets and our rooms, the red so highly prized for personal ornaments, and the black, which is scarcer than either, but to them it is given in the course of years to form dangerous coral reefs on which many a vessel has been lost, and even to build up new islands.

How is it possible that such tiny creatures as you describe should be able to make islands?

It appears that each successive generation of them builds its habitation above those of the ones who have gone before, thus the mass continues rising, the lower part being dead and uninhabited, the upper surface full of life and animation; each little polype dwelling in its hole, and stretching out feelers, or, as they are called, *tentaculæ*, of varying length, which serve to catch the minute animalculæ on which it feeds. The same instinct which teaches this tiny worker always to add to its building in an upward direction, seems also to have induced it to choose the most favorable points for commencing the structure. A glance at the map of the islands of the Pacific, so many of which are of coral origin, will show them to be apparently placed on the tops of ranges or groups of submarine mountains, and thus, though there are instances of coral reefs rising almost perpendicularly from a depth of twelve hundred feet, such is not often the case. When the mass of coral rises to low-water mark, the polypes no longer build upward, but other agencies come in to finish the embryo island; high tides and storms contribute broken pieces of rock, coral, sand, and sea-weeds; salt plants vegetate on the reef, and sea-birds come and visit it; by degrees a soil is formed by the decay of vegetable substances, and the crumbling of mineral ones, from exposure to wet and a tropical sun, and then perchance some stray cocoa-nut, which may float long in the salt water without losing its vitality, is washed on shore, it takes root, and becomes the parent of a tropical forest, for, as soon as trees appear, the islands are visible from a distance, and land birds are attracted there, bringing with them the seeds of many land plants, till at last the coral reef becomes a fertile island, fitted in every way for the habitation of man. Many of these islands are either wholly or partially surrounded by a ring of coral rocks at some distance from the shore, which, though it renders the approach to them difficult, affords sheltered harbors which they could not otherwise possess.

Where does Coral come from?

It is found in great abundance in the Mediterranean, the Red Sea, and the Persian Gulf; and also, as you will already have concluded, in many parts of the Pacific Ocean. The depth at which it is found is very various—all that appears important is, that the coral insects should always be below low-water mark, and that the rays of the sun should readily penetrate. It is obtained by dragging the bottom of the sea with a heavy kind of cross, armed with strong hooks, and loosely twisted all round with soft ropes, which entangle the pieces of coral broken off by the bar and hooks, and bring them safely to the surface.

What is Sponge?

It is a marine substance of the same class as coral, being in fact the dwelling-place, or rather skeleton of a whole colony of polypes; for these strange little creatures carry the principle of having all things in common so far, that they actually have one household skeleton, on which their separate, tiny, pulpy selves exist, and which they all help to form. In their first stages of existence, sponges are little gelatinous bags, apparently possessing the power of swimming; they finally fix themselves on a rock; their skeletons begin to be formed from some internal secretion of their own; and then they never move again, but grow and grow till the mass is like the sponges we see; only it is always covered with the jelly-like living covering, furnished with pores or mouths which suck in the sea-water for nutriment, and larger holes through which it is expelled.

Where do Sponges come from?

There are a very great number of different sponges, and some variety is found on almost every shore, but those we use for washing are chiefly brought from the Mediterranean Sea, and the Archipelago; these sponges are obtained, some by dredging, and some by diving; the latter mode is rendered more easy than it otherwise would be, by the exquisite transparency of the water, which enables the diver to discern his desired object growing at the bottom of the sea.

What is Indian-Rubber?

Indian-rubber, or, as it is sometimes called, *Caoutchouc*, is the dried juice of several Asiatic and American trees. That which comes from Asia is mostly derived from the *Ficus elasticus*, a large and handsome tree of the fig genus, which towers above the surrounding forest, growing either solitary or in groups of two or three. One trunk which was measured was found to be seventy-four feet in circumference, and they sometimes attain the height of upward of one hundred feet. It is calculated that, in a belt of forest thirty miles long and eight wide, which exists in one part of Assam, there are more than forty-three thousand of these trees. The South American caoutchouc is the produce of the *Jatropha elastica*, and the *Siphonia elastica*.

How is Indian-Rubber obtained?

In the cooler part of the year the bark is cut through, when a white milky juice exudes, which in South America is generally applied at once to the outside of clay moulds, and dried. After repeated layers have been applied, when quite a thick substance is produced, the mould is crushed, and the fragments are removed through the neck of the flask formed; as this drying process is often performed in the smoke, the juice by this means becomes black. From the East Indies it is imported in lumps or balls, and sometimes the juice itself is brought over in close-stopped vessels.

What is Indian-Rubber used for?

It was first used for rubbing out pencil-marks on paper. It is extremely elastic, so much so, that a small indian-rubber bottle, only a few inches in diameter, can, after being softened in warm water, be inflated with air till it is six or seven feet in diameter, and semitransparent. This quality makes it very useful for forming bands and straps, and for weaving into a kind of cotton web, which is used for similar purposes; children's playing-balls are also made of small globes of indian-rubber inflated with air. This brings us to another of the useful qualities of this curious substance, it is perfectly insoluble in water and impervious to both water and air, hence its use in making water-proof fabrics and air-pillows, these are generally made by spreading a thin coating of caoutchouc dissolved in spirit, between two surfaces of the cloth, which by this means are firmly glued together, and made perfectly water-proof. The uses to which indian-rubber and its congener gutta-percha, a more recently discovered and more solid article, are applied, are too numerous to mention; tubes, pipes, straps for machinery, trays, picture-frames, ink-bottles, whips, sticks, combs, boxes, chairs, tables, sofas, and all sorts of furniture are formed of it.

What is Gutta-Percha?

It is as I have told you another substance similar to indian-rubber, being the dried sap of the *Isonandra gutta*, a tree growing in Malacca, Singapore, and some other eastern places.

What are Hats made of?

Most of the hats now worn are made of chip, cork or some other light substance, and covered with silk which is woven for that purpose, being in fact a long and very smooth-haired plush; these hats formerly worn were made of felt covered with beaver down or rabbits' down: they were dear, hot, and heavy; and though common only a few years ago have been almost entirely superseded.

What is Felt?

It is a curious substance made without any weaving, and owes its origin to the tendency that fibres of wool have to mat together under pressure, and interweave so as to form a durable and firm web. In order to make felt, the wool, down, etc., are first bowed to separate the fibres, the two materials are then united, spread out evenly and pressed; this forms a rough felt, very loose and imperfect; the next operation is to knead and roll it with the hand, which renders it much more compact. After this it is taken to the edge of a boiler, containing wine or beer lees, water, and sulphuric acid, almost at boiling point, and it is well worked in this mixture, which shrinks it. The felt is now a hollow cone, and is next stiffened by being brushed over on either side with a solution of shell-lac in spirit; this not only stiffens the hat but renders it water-proof.

What queer-looking things these hats must be, of a conical shape and daubed over with shell-lac; what is done to them next?

The *nap* is put on, which is composed of the fine down of the beaver, the rabbit, and other small animals; this fine, soft nap is felted on, and the whole hat is worked over a block till it assumes the proper form; it is next dyed black, the crown strengthened by putting in a round disc of chip or pasteboard, and the nap raised and smoothed by hair-brushes and warm irons; lining and binding are then the only operations needed to fit the hats for wear.

Where do the Beavers live whose hair you said was used for making Hats?

The beaver is a native of North America; it is a small animal, covered with hair of two kinds, one fine and soft, and the other long and coarse, and has a remarkable, broad flat tail, covered with scales, which serves the double purpose of a rudder to guide his course, and a trowel to build his house.

His house! what sort of a house does he build?

The beavers live in company, and a number of them having selected a stream suited for their dwelling, commence making a dam across it; for this purpose they gnaw down trees with their strong sharp teeth, and instinct teaches them to do this in such a manner that the trees shall fall across the stream; the interstices are then filled up with mud and clay, and the whole plastered neatly by the broad tails of the little builders; in the quiet water which this dam secures them, they build their huts in a rounded form, and having several separate cells in each, the floors of which are often strewed with leaves or small branches of fir-trees. The beaver is quite amphibious, that is, he can live either on land or in the water; his food is roots, fruits, and water-plants.

What are Anchovies?

Small, soft-finned fishes of the herring species, inhabiting the tropical seas. They are caught in the Mediterranean from May to July, the fish during this period leaving the Atlantic to deposit their spawn on those shores. The fishing is carried on by night, the anchovies being attracted by the charcoal fires which are burned in the stern of the boats. The head, gills, and entrails of the fish are removed, and the bodies salted and packed in small casks, in which they will keep for a long time, if the air is excluded.

What is Eider-down?

An exquisitely soft and elastic down, obtained from the eider-duck. These birds build their nests among precipitous rocks, and the females line them with fine feathers plucked from their breasts. The natives of the districts where they abide let themselves down by cords among the dangerous cliffs, and collect the down from the nests. These ducks are abundant on the shores of Davis's Straits and Baffin's Bay; also in Lapland, Norway, Iceland, Greenland. It is stated that some elder-ducks pass the winter season on the coast of New Jersey, and a few have been obtained off Boston, and at Eastport in Maine. They rarely move further southward in winter than to permanent open water.

What is Putty?

A kind of paste or cement, compounded of whiting or carbonate of lime and linseed oil, kneaded to the consistence of dough. In *architecture*, a very fine cement, made of lime only.

What is Quicklime?

Limestone freshly burned, and deprived by that means of its carbonic acid. The operation is conducted in kilns constructed for the purpose; the limestone is exposed to a red heat, by which means the carbonic acid is expelled. In this state, when sprinkled with water, it becomes very hot, and crumbles into a dry powder, called slaked lime.

What is Terra-Cotta?

Literally baked clay, but the name is given to statues, figures, vases, etc., modelled or cast in a paste made of pipe or potters' clay and a fine-grained colorless sand, with pulverized potsherds, slowly dried in the air and afterward fired to a stony hardness in a kiln. Terra-cotta is the common name for a very large class of remains of antiquity; a collection of these in the British Museum is of great interest; among them are vases ornamented with the most exquisite skill, and which, independent of the excellence of the painted embellishment, exhibit a remarkable beauty of outline. A portion of them appear to have their colors burnt in; with others the embellishments are painted on the surface.

What is Creosote?

A colorless, transparent, oily liquid, distilled from wood-tar; it appears to be the antiseptic power of wood-tar, smoke, etc. Its action upon animal matter is very interesting; it prevents the putrefaction of butchers' meat and fish, coagulates albumen, and it is inferred that it is owing to the presence of creosote that meat is cured by smoking. It kills plants and small animals; in certain cases it is a valuable medicine, in others a powerful poison.

What is Albumen?

A constituent of the fluid part of the blood, and of the sap of some plants—the potato, parsnip, carrot; the white portion of the egg is in great part albumen, to which substance it owes its name. Albumen in its natural or uncoagulated state has little taste and no smell. When dried spontaneously in a low heat it becomes a brittle, transparent, glossy-like substance, which, when spread thin upon substances, forms a varnish, and is accordingly employed by book-binders for that purpose. When thus dried it resembles gum-arabic, to which also its taste is similar.

What is Hartshorn?

The articles denominated *spirits of hartshorn* and *salt of hartshorn* were originally obtained only from the horns of different species of deer, to which very extraordinary virtues were attributed; but they are now chiefly prepared from bones, or by a direct solution of the pure carbonate of ammonia. When hoofs, bones, tendons, horns, etc., are heated in iron cylinders, they are decomposed, and a product is derived, partly liquid, partly concrete, which is termed the carbonate of ammonia, and which, when separated from an empyreumatic oil that accompanies it, is called *spirit of hartshorn.* Ammonia is a volatile alkali, found in the vegetable and the animal kingdom; it is found united with native oxide of iron, in charcoal, and all soils which are turned up and exposed to the air. Rain-water contains traces of ammonia derived from the air, in which it is present in minute quantities. It is manufactured usually from slaked lime.

What is Vanilla?

The fruit of a plant of the orchidaceous order, climbing over trees in tropical parts after the manner of ivy. The fruit is a long pulpy pod, in which resides a liquid of exquisite odor, known as the balsam of vanilla. This balsam, however, is rarely exported; the mode is to dry the pods in the sun; afterward slightly ferment them, and in this state they are sent to market. Vanilla is used extensively in flavoring chocolate, ices, creams, and confectionery; it acts upon the system as an aromatic stimulant, exhilarating the mental functions, and increasing generally the energy of the animal system.

What is Glycerine?

A nearly colorless viscid liquid, obtained from olive-oil or other fatty substances. It has a very sweet taste, and is of a sirupy consistence. It is used in soup, and is of a healing nature; it mixes with water in all proportions, and is not fermentable.

What is Bird-Lime?

A glutinous substance derived from the bark of the holly by a process of boiling. A similar substance can be obtained from mistletoe, and from the young shoots of the elder. It contains resin, mucilage, free acid, and coloring matter. It is used to catch birds, and for this purpose the twigs of bushes are smeared over with the viscid substance. It is used in India for destroying insects.

What is Borax?

A salt formed by a combination of boracic acid with soda. It is found native in some of the lakes of Thibet and Persia, and is imported from India under the name of *tincal*, which, after purification, forms the refined borax of commerce. It appears in crystalline masses of a moderate size, or in distinct hexagonal prisms, terminated by three or six sided pyramids; is of a white color, and transparent. When heated, water of crystallization is driven off, and the residuary salt fuses into what is called *glass of borax*.

What are the uses of Borax?

It forms one of the best fluxes known. It is used in the analysis of minerals by the blowpipe, in melting the precious metals, in forming artificial gems, and in soldering. When mixed with shell-lac, it renders the lac soluble in water, and forms with it a species of varnish.

What is Oakum?

The substance into which old ropes are reduced when they are untwisted, loosened, and drawn asunder. It is used in calking the seams of vessels for stopping or preventing leaks.

What is Chloroform?

A peculiar limpid fluid obtained by distilling a compound of chloride of lime and alcohol. It is used for producing insensibility during surgical operations, for which purpose it was first employed by Drs. Jackson and Morton of Boston—a discovery which has been justly pronounced as second only in its beneficent effects to that of vaccination as a preventive of small-pox by Dr. Jenner. It acts upon the system, when inhaled, by suspending the functions of animal life, as sensation, consciousness, and volition. In this state the person is, as it were, in a profound sleep; he is incapable of movement, and while digestion, respiration, circulation, and all the functions of life go on perfectly well, he is insensible to external impressions. The vapor of ether, a compound produced by the distillation of sulphuric acid and alcohol, has been used for the same purpose, but chloroform is usually preferred; a smaller quantity is required, it is more rapid in its action, and its effects upon the system are less marked and lasting.

What is Lunar-Caustic?

Caustics are a class of substances employed to create artificial ulcers for the purpose of relieving some deep-seated malady, the chemical operation of which is a supposed attraction between the animal body and the substance employed. Lunar-caustic is most commonly in use; it is obtained by evaporating gently the nitric acid solution of silver to dryness in a silver vessel, continuing the heat until it melts; and when in fusion, pouring it into moulds, or casting it into sticks the size of the barrel of a common quill.

How is Gunpowder manufactured?

Gunpowder is a mixture of saltpetre, sulphur, and charcoal. If we may believe the relations of the missionaries, and the reports of the Chinese historians, the Chinese were first acquainted with the application of gunpowder. It appeared to pass from them to the Arabs, for the Moors used it in 1331 in their operations before Alicant. The first indication we can discover of its presence in Europe is in Germany during the fourteenth century. In the manufacture of this article, the crude saltpetre is broken up, moistened, and exposed to the action of a slow fire, continually skimmed and violently agitated, till all the moisture evaporates, and the saltpetre remains in the form of a fine powder. The sulphur is pulverized after being well purified. The charcoal used is that derived from the alder, or some soft wood, and burned with great care in a confined room. The three ingredients are pressed in a rolling-mill, and while in a moistened state the compound is pressed through a perforated sieve, by which the powder is formed into grains; it is then dried by a slow heat, and at last sorted by being passed through several sieves of various degrees of fineness. The theory of the action of gunpowder is this: "That part of it on which a spark falls is immediately heated to the temperature of ignition; the saltpetre is decomposed, and its oxygen combines with the charcoal and sulphur, which are also heated; this combination extricates as much heat as is sufficient to inflame successively, though rapidly, the remaining mass. The cause of the expansive force of gunpowder is the production of carbonic acid, carbonic-oxide, and nitrogen; and these being liberated at a very high temperature, the effect is greatly increased."

What is Saltpetre?

A natural compound of potash and nitric acid. It is found in those soils where animal substances and lime are in contact, and there being evaporated to dryness, crystals of saltpetre are formed. The principal portion used in this country comes from the East Indies; but saltpetre is collected in several of the states of the Union.

What is Gun-cotton?

Gun-cotton is a modern invention. It is obtained by steeping purified cotton in a mixture of nitric and sulphuric acids. Its force is remarkable, being triple that of gunpowder of equal weight. Burned on the hand it causes no pain and leaves no stain; it produces no smoke; so wonderfully rapid is its explosion that a piece of the cotton laid upon gunpowder may be exploded without igniting the powder. In practice gun-cotton is adapted for mining and blasting, but not for gunnery.

About Oils.

Will you tell me something of the nature of Oil?

There are two products to which the term oil is applied, which are usually called *fixed* oils and *volatile* oils. Fixed or fat oils are either of vegetable or animal origin; they abound in the seeds of certain plants, from which they are extracted by pressure; hence the term expressed oils is sometimes applied to them. They have color, odor, and taste; are usually fluid, but of a thick consistence; the most perfect are the olive-oil, from olives; almond-oil, from the seeds of the almond, and linseed-oil, from flaxseed. Expressed oil combines with the alkalies, and forms soap.

Volatile or essential oil is contained in the flowers, fruits, leaves, wood, of many vegetables; when distilled in water an oil passes over along with the steam, and floats on the surface of the water. This is the volatile oil, which is converted into vapor at a very low heat. It will not serve for purposes of illumination; in general it is used as perfumes, or in the practice of medicine. Some of the volatile oils enter into the composition of varnishes. Volatile oil usually exhibits the peculiar smell, and often almost the taste, of the plant from which it is extracted. In this way are obtained the oils of roses, lavender, lemons, orange-flowers, cinnamon, peppermint, etc., all of which retain the characteristics of the plants from which they have been derived. The volatile oils have a powerful smell; their taste is acrid, pungent, and heating; some of them are almost caustic; they are not greasy to the touch, like the fat oils, but, on the contrary, make the skin feel rough. When exposed to the air they absorb oxygen, lose their color and smell, turn gradually thicker, and eventually change into a solid matter resembling resins. Volatile oils constitute the odorous and sapid principles of plants. They evaporate so readily that their adulteration by any of the fixed oils may be easily detected by a drop of the oil being applied to white paper. The greasy spot will entirely disappear if held before the fire, provided the essential oil be unmixed; but if a fixed oil has been added, the greasy stain will remain.

What is the mode of distilling Volatile Oils?

The mode of distilling volatile oils is as follows:—The plant is introduced into a still; water is poured upon it, heat is applied, and the oil is volatilized by the aid of the watery vapor at the temperature of 212°. The mingled vapors of the oil and water are condensed into the liquid state, the oil either sinks to the bottom or floats on the surface. A few volatile oils are procured from simple pressure; others, however, are so easily destroyed by these processes that they can only be obtained by the power which the fixed oils have of absorbing them. Thus, essence of jessamine is obtained by placing layers of cotton or wool, saturated with the fixed oils of almonds or of poppy seed, both of which are themselves odorless. They soon absorb the essential oil naturally emitted from the flowers, and become highly perfumed. Fresh layers of flowers are supplied until the fixed oil is saturated with the odorous particles. The cotton or wool wadding being next subjected to distillation along with water, gives up the volatile oil.

Of the fixed oils I have in other places mentioned olive-oil, palm-oil, and castor-oil. In addition to these are—*linseed-oil*, expressed from the seeds of the common flax; when no heat is employed in the pressing it is more viscid and has a greenish-yellow color, it is then called in commerce cold-drawn linseed-oil; its smell and taste are more decided than olive-oil; it is used in oil-painting and varnish making. *Cocoa-nut oil* is white, of a pleasant smell, and agreeable taste; *almond-oil*, more fluid than olive or linseed oil; odor and taste very slight; spermaceti-oil and the common whale or train oil, obtained by melting the blubber of the animal; spermaceti-oil is procured from the oily matter lodged in the head of the spermaceti whale. The other animal oils are of inferior importance unless we except neat's-foot oil, which is obtained from the bones of the feet of oxen. It is procured by boiling the bones, and skimming off the fatty oil as it rises to the surface of the water. Neat's-foot oil remains liquid at a low temperature, is not liable to rancidity, and is peculiarly well adapted for machinery.

Will you name the principal volatile oils?

Oil of turpentine, obtained from the pine-tree; holes are made in the base of the stem, from which a very large quantity of the fluid substance called turpentine flows and is collected in casks. This is of a light-yellow color, and of the consistency of thin honey; but some gets hard by the evaporation of its essential oil. Turpentine when distilled yields about twenty-five per cent. of a thin, colorless essential oil known as spirit, or oil of turpentine; *oil of aniseed*, from the seeds of the anise or pimpinella; *essential oil of bitter almonds*, distilled from ground almond-cake, a very different oil to that which is *expressed* from almonds both bitter and sweet; *essence of bergamot*, from the rinds of the bergamot-orange, by pressure, (see bergamot); *oil of cloves*, from cloves, soaked and distilled with salt water; *oil of camomile flowers; oil of hops*, obtained during the boiling of hops in beer; *essence of jasmine*, from the flowers of the jasmine; highly fragrant and delicate, used by perfumers only; *oil of lavender*, from the lavender-flowers of the narrow-leaved lavender; *oil of sweet marjoram*, from a peculiarly aromatic and fragrant plant of the order *origanum; oil of peppermint*, used principally by the confectioners; *oil of mace*, from the spice of that name; *essence of myrtle*, the water distilled from myrtle-flowers, which, as in the case of all the waters distilled from plants, retains a minute portion of the oil, and forms that agreeable perfume known in France by the name of the *eau d'ange; oil of pimento*, from allspice; *oil of penny-royal*, from the herb of that name; *oil of mint* is distilled from the whole plant of the common mint; *oil of cassia*, distilled from the bark of *cinnamomum cassia*, is manufactured in China, and imported in considerable quantities, usually in chests like those used for tea, each containing four tin canisters filled with oil. It is used in perfumery; *oil of cinnamon*, distilled from cinnamon, possesses, when pure, all the delicious flavor and pungency of the spice, and is used for similar purposes, small quantities only are imported from Ceylon; *oil of birch*, is distilled in Russia from the bark of the common birch; it has a sweet cedar-like odor, and is used in dressing Russia leather, to which it communicates its peculiar smell; *oil of rosemary*, from the flowering tops, sweet-scented.

What is Otter or Attar of Roses?

An oil distilled from the evergreen and the musk rose. At Ghazepoor, on the Ganges, are thousands of acres upon which the rose is cultivated for this purpose. In the morning the rows of rose-bushes are red with blossoms, but these are gathered before the midday, and their leaves distilled. The water which comes over is placed in open vessels, but covered so as to be protected from impurities, and exposed all night to the cool air, upon the same principle that we set out milk for cream to gather. In the morning a thin film of oil is collected on the top, which is carefully gathered on a feather, and emptied into a prepared phial or vessel. This process is repeated until the water has given off all of its oily constit-

uent. The quantity of oil yielded by the rose is very small, and hence its great value. It is stated that it takes two hundred thousand roses to produce half an ounce of the attar. The pure article, therefore, is very rare, ar
mands a high price.

About Cosmetics and Perfu

The term cosmetic, which is derived from a Greek word, that signifies "I beautify," may be understood as referring to every kind of personal adornment, with the exception of dress. It has, therefore, a rather wide signification, comprehending not only skin colors, such as pearl-white, rouge, etc., but pomatums, depilatories, fancy soaps, and numerous other substances, which the memory of the reader will not fail to supply.

The practice of using cosmetics is of very ancient date, the use of bodies for personal adornment being, in point of fact, suggested by a leading sentiment of humanity. The use of cosmetics is mentioned in several parts of Holy Writ, and a notion of the prevalence of these substances amongst the classic people of antiquity may be gleaned from the writings of Ovid, Martial, Suetonius, Juvenal, etc.

Closely allied with cosmetics, in the strict sense of the term, are perfumes; the professed objects of which generally have reference to some improvement of personal appearance, as well as the diffusion of an agreeable odor. Exquisite as are more modern perfumes, and large though the consumption of perfumery undoubtedly is at the present day, the luxurious Greeks of antiquity, and the Romans also, at a certain epoch of their history, surpassed the moderns in this respect. Inasmuch, however, as alcohol was a thing unknown to the ancient Greeks and Romans, their perfumes were, for the most part, confined to such as had an oily basis. The value of perfumes as curative agents was presumed to be greater by the Greeks and Romans than we moderns admit, or even imagine. An appropriate perfume was given to each particular organ. Palm-oil was considered good for the cheeks and breasts; balsam mint for the arms; marjoram for the eyebrows and hair; and wild thyme for the knees and neck. The odor of violets was held in great esteem amongst the Athenians. Myrrh was a great favorite both amongst the Greeks and Romans. Not only did it enter as a constitnent into most of the perfumed ointments, but it was burned in chambers, after the manner of a pastille.

I have already alluded, in the discussion of oils and at other times, to a few of the powders and essences most esteemed at the toilet. There remain, however, several important substances not yet described.

What are the substances chiefly employed as Cosmetics?

Rouge, talc, or French chalk, pearl-white, carmine; of the essences, patchouly, bergamot, cologne, civet, lavender, etc.

What is Bergamot?

The essence of bergamot is the essential oil of the rind of a small, pear-shaped fruit called the bergamot orange, *Citrus bergamium*. The oil is obtained by pressure; it yields abundantly, and ranks high among the perfumes.

What is Lavender?

The tincture of lavender and lavender-water are prepared from a delightfully fragrant plant, a native of the south of France, though now commonly cultivated in our gardens. Its properties are aromatic and stimulating, especially when growing in a warm climate, in which situation it sometimes contains one-fourth of its weight in camphor.

What is Patchouly?

An extract from an herb resembling our garden sage, which grows extensively in India and China. The odor is derived from an otto contained in the leaves and stems, which is easily procured by distillation, and is the most powerful of all odors derived from the botanic kingdom. The peculiar smell of India or Chinese ink, arises from the admixture of this herb. The origin of the use of patchouly as a perfume in Europe is curious. When the real India shawls were first imported they bore an extravagant price, and could always be distinguished from imitations by the peculiar odor they possessed. The French succeeded in imitating the fabric admirably, but they could not impart the odor, nor devise the secret of it in the genuine articles. At length it was discovered that the true Indian shawls were perfumed with patchouly; hence they imported the extract, and succeeded in palming off the homespun articles as real Indian. From this origin the perfumers brought it into use.

What is Verbena?

The scented species of this plant gives one of the finest perfumes with which we are acquainted; it is well known to yield a delightful fragrance by merely drawing the hand over the plant; some of the little vessels or sacks containing the otto must be crushed in this act, as there is little or no odor by merely smelling at the plant. The oil is extracted by distillation; its great cost renders it commonly and successfully imitated.

What is Eau de Cologne?

Eau de Cologne (literally, water of Cologne) is a fragrant water or alcohol aromatized, made originally and in most perfection in Cologne. It was invented by a person named *Farinâ*, in whose family the secret, as they say, continues to be preserved, since chemistry has not been able to give the analysis of it. It is imitated, however, everywhere; various recipes are given for its manufacture. The genuine is said to consist of alcohol, to which is added sage, thyme, camphor, petals of roses and violets, balm-mint and spearmint, root of angelica, lavender, nutmegs, cloves, mace, essence of lemon, bergamot, jasmine, etc. Formerly many wonderful virtues were ascribed to this water, and it has always been a favorite companion of the toilet. The consumption is immense; in Cologne several millions of bottles are manufactured every year. In many other German towns the imitated article is extensively manufactured.

What is Civet?

A substance taken from the civet-cat, an animal, a native of northern Africa, where it is sometimes domesticated for the sake of its secretions, which partake of a musky character. In confinement it is a sleepy animal; when irritated the musky odor becomes stronger. When the bag which contains the secretions become filled, the substance falls out in hardened pieces about the size of an almond. It is a perfume much valued in the East.

What is Musk?

A singular and highly-scented article, obtained from a secretion of the musk-deer, a small animal which inhabits the Alpine regions of the Himalayas and other mountains in the east of Asia. The scent of musk is the most powerful and durable that can be imagined; a cork which had stopped a phial containing musk, but which did not touch it, has been known to retain its scent twenty years after being removed; and drawers once scented with musk, scent every thing put into them for years after.

What is Ambergris?

Ambergris is much used in the composition of perfumes, but its origin has not been satisfactorily ascertained. It is supposed to be a morbid concretion in the spermaceti whale. It is found floating on the sea or the sea-coast; it resembles amber, but is opaque, fatty and inflammable, exceedingly light, and melts with readiness. It is usually joined with musk. The odor is agreeable, but so strong that a small quantity in a few minutes will perfume a whole chamber.

What is Rouge?

A red paint for the face, so named from the French word for red. It is usually produced from the coloring matter of the safflower, joined with talc or powdered French chalk. The flowers are washed, dried, pulverized, and digested in a weak solution of carbonate of soda, which extracts the color, and to precipitate this in form of powder, lemon-juice or vinegar is added, and the coloring matter becoming disengaged falls upon filaments of cotton or wool, previously prepared for its reception. The cotton is then washed, and the color precipitated again, by more acid, upon finely-powdered talc, and afterward it is triturated with a few drops of olive-oil.

What is Carmine?

A red paint prepared by precipitating the coloring matter of cochineal upon alumina, the earthy constituent of alum. With respect to red paints used for cosmetics, the vegetable reds alone are safe; such as those made from cochineal, safflower, Brazil-wood, etc.; these are dyeing substances, and are harmless applications for the skin; but the mineral reds, such as vermillion, minium, red lead, etc., are pernicious, and under no circumstances should be admitted to the toilet.

What is Pearl-White?

Pearl-white is a preparation of bismuth, obtained by pouring a solution of the nitrate of that metal into a dilute solution of sea salt, whereby a light and very white powder is obtained. It is very poisonous to the skin, and, if exposed to the fumes of sulphur, will turn black. An amusing anecdote is told, illustrative of its peculiar quality in this respect. At a lecture, water impregnated with sulphurated hydrogen was handed round for examination. A lady to whom it was passed smelled of the liquid, and instantly became *black in the face*. There was general alarm; and the lecturer, in accounting to the audience for the phenomenon, was compelled to expose the secret of the lady's toilet, equally to her mortification, no doubt, and the amusement of the assemblage.

Which are the safest Cosmetics?

The vegetable extracts are infinitely superior to the mineral ones; but the *best* cosmetics are soap and water, exercise, air, and temperance.

What is Orris Root?

The root of the *Iris Florentina* comes from Florence; is white, and has an agreeable odor very much like violets. It is used as a dentifrice and to perfume powders.

What is Pomatum?

The pomatum of the present day consists of perfumed grease, of which that known as "bears' grease" is the greatest favorite; ox-marrow and other fats are used for the same purpose. But, strictly speaking, the term "pomatum," as applied to these preparations, is misused. The original composition was called pomatum from its containing apple (*pomum*, Latin). Gerarde tells us:—"There is made an ointment with the pulp of apples and swine's grease and rose-water, which is used to beautify the face and take away the roughness of the skin, which is called in shop pomatum, of the apples whereof it is made." The pomatums of the present day do not contain a particle of apple.

About the Human Body.

It has been remarked, and not without cause, that, fortunately, we are not transparent. If the complexity of our mortal mechanism could be seen—the heart pumping, the arteries conveying the stream of life to the farthest limits of the system, the veins bringing back the deteriorated blood, the lungs purifying it and rendering it once again adapted to the purposes of corporeal invigoration—if all these functions, and many others of which the human body is the theatre of action, could be made evident to us, we should move about in anxiety and trembling, fearful of damaging a machine so complex, so wonderfully put together. On the other hand, the position is undoubted, that of the vital functions, most of us take far too little heed. We crave after health and longevity in the abstract, but too frequently neglect the most obvious means by which those ends may be secured. We endeavor to compensate for our neglect or ignorance of these matters by invoking the physician's aid—not unfrequently counteracting the efficacy of medicine by adopting practices and modes of life in direct antagonism to the most obvious laws of health. An acquaintance with the outlines of anatomy, or the construction of our frames, and physiology, or the knowledge of their functions, might save us from many evil consequences.

Will you give me some account of the construction of the Human Body?

The human structure, viewed in the aggregate, is a beautiful machine, every part of which is so admirably adapted to the fulfilment of an end, that by it we see better than through the medium of any other study, the evidence of Omnipotent design. In dealing with this subject some kind of classification will be necessary; we propose to take the matter up in the order followed by the professed anatomist. We will commence with the skeleton, or the bones. The thought of a human skeleton strikes many people with repugnance. But the feeling is not natural, or at least vanishes with a little familiarity with the subject. But few people can long ponder over a skeleton, and examine its beautiful adaptations, without altogether losing the consciousness of this feeling of horror, and being impressed with the admirable fitness of every part.

In looking at the skeleton in the aggregate, the part which most prominently displays itself is the peculiar structure of what is commonly called the "backbone."

Anatomists term it the vertebral column, I believe?

Yes, and a very expressive denomination too it is; seeing, firstly, that it is columnar, and that the column, instead of being made up of one bone, is made up of no less than twenty-four, all of them capable of more or less motion on each other; they turn on each other in point of fact—whence, from the word *vertere*, to turn, the propriety of the term vertebral column, or simply the vertebræ, becomes manifest.

The *vertebral column*, or *backbone*, consists, as already stated, of no less than twenty-four bones, no two of which are precisely alike. The bones of the vertebral column, when joined together, as in the human body, form a canal, through which passes a soft substance, commonly known as the spinal marrow. Very different, however, is this from ordinary marrow, being, in point of fact, composed of nervous matter, like that which forms the brain. Let us now contemplate how admirably the vertebral column is formed with reference to its duties and uses. Firstly, it has to be very strong, because a host of muscles are connected with it; the vertebral column, too, has to be pliable, admitting of motion to a variable extent, and toward the head of motion in every direction. Were it not for this facility of motion, the vertebral column might as well have been made up of one single rigid bone at once; but what a position should we have been placed in—unable to bend our backs, much less our heads! A crocodile made to stand upright would have been scarcely so unwieldy. Now, these requisites, so indispensable to the proper functions of the vertebral column, are antagonistic to each other. A problem of greater difficulty could not perhaps be given to the engineer than that of protecting a delicate cord from external injury by surrounding it with a hard sheath capable of omnilateral motion. Yet how completely this problem has been solved by the great Architect of our bodies, in the vertebral column, may be inferred from the rare occurrence of accidents! Serious injury to the spine is an unfrequent calamity, and the grave character of the kind of injury, when it occurs, is a sufficient indication of the care which nature must have taken by way of provision against it.

Although every portion of the vertebral column, except the lowest extremity, is capable of some amount of motion, yet as between any two adjacent bones of the column, with two remarkable exceptions, the amount of motion is small. The greater amount of mobility participated in by two vertebræ evidently refers to those which permit the motion of the head. The circumstance scarcely needs to be indicated that the motion of which the head is capable is far more considerable than the motion of the back. Backward or forward, or on either side laterally, the head is capable of a motion both extensive and universal.

Is this motion attained by what mechanicians would term a "ball-and-socket" joint?

No; it is not thus that nature has gained her ends. Had there been a ball-and-socket joint, the quality of freedom of motion would have been indeed imparted, but the first turn of the head to any considerable extent, in any direction, would have been necessarily fatal, inasmuch as the spinal marrow must have been severed, had not some special provision been made against it. The device, therefore, has been adopted of providing two vertebræ, each imparting a different class of motion. The first vertebra is called by anatomists "atlas," because it supports the skull, or head, just as the Atlas of mythology was fabled to support the world. Upon this atlas the skull rests, and suitable provision is made for all the backward and forward, or nodding motion of which our heads are capable, but nothing more. The lateral or rotatory motion is accomplished by the joint which exists between the first, or atlas vertebra, and the second, to which the appropriate term "axis" is applied.

Even in the human being the structure of the backbone is wonderful; but he who would contemplate the various and seemingly antagonistic functions of a backbone displayed in the most extreme degree of which they are capable, should turn to the skeleton of a serpent. What can be more seemingly free and unconstrained than the motions of a snake as it glides over the surface of the ground, or climbs a tree, or darts its head, with the velocity of a spring unbent, against the prey on which its eye has rested? The bodies of these creatures appear to have a rope-like flexibility to such an extent that the idea of their possessing backbones might be almost deemed impossible. Yet backbones they have, like our own in character, though far more wonderfully constructed, inasmuch as the freedom of motion possessed by them is greater, and the force which they are enabled to apply is tremendous. The backbone of the boa-constrictor is composed of no less than three hundred and four distinct bones, to no less than two hundred and fifty-two of which ribs are attached. And, while on the subject of the ribs of serpents, the fact may as well be noticed that the ribs of these creatures not only serve the proper functions of ribs, *i. e.*, to confine and protect the visceral organs, but they also to a certain extent perform the office of legs.

Returning once more to the backbone of a human individual, let us view it in the aggregate. Omitting minor points of consideration, such as would be noticed only by the anatomist, let us observe what a veritable line of beauty it makes when viewed laterally. It is bent into three well-marked curves; the largest of these corresponds with the hollow of the back, and its concavity looks backward; the concavities of the other two look forward respectively, the upper one contributing to give a graceful curve to the neck; the curve of the lower one not being recognizable, except in the skeleton, because it is lost in the contour of the hips.

What are the bones of the Chest?

The chest, or thorax, is the cavity which contains the lungs, the heart, and other less important organs. The bony or skeleton part of the chest is suggestive of the rib-work of a ship; and indeed the rib-work of our bodies largely contributes to the formation of the human chest—twelve pairs of ribs, two sternum or breast bones, and twelve vertebræ, or pieces of the backbone, entering into its construction. Glancing at the contour of the skeleton chest, you will not fail to recognise its well-marked conoidal form, the apex of the cone pointing to the neck, and the base of the cone corresponding with the lower part of the chest. You may propose to yourself the question how this bony rib-work can be accommodated to the varying fashion of ladies' waists—rising upward, or falling downward, as they are accustomed to do, at the tyrannical dictum of the last ukase from Parisian modistes. Nothing can be more readily demonstrated than this: the smallest part of a lady's waist ought not to begin higher up than the twelfth rib; and if she violate the anatomical dictum by any external skeleton-work of whalebone and steel, she can only do so at the expense of rendering herself a monster to the appreciation of every eye educated in accordance with the true principles of beauty. Of ladies who err to any considerable extent in the distortion of their chests by the forced restraint of stays, it may be averred, in more senses than one, that their hearts are not in the right place.

A second glance at the general bony contour of the chest will, perhaps, cause you to ask whether some inversion of parts has not occurred. Looking at the human chest, instead of the mere bones of the latter, the notion of a cone is still conveyed, but the apex seems to look downward. This results from the mass of external fleshy and other covering, more developed in woman than in man, and by the presence of which the beautiful rotundity of bust is given.

Which are the next most important bones?

Omitting for a time the examination of the bones of the head, the next system of large bones which presents itself to our notice is that of the pelvis or hips. The pelvis forms the lowest part of the trunk; it consists of a pair and two single bones, which you will hardly take the trouble to examine individually; nor shall I burden your memory with their anatomical names. The anatomist can readily discover from its general appearance whether the skeleton viewed in the aggregate, or individual portions of the skeleton, belong to a male or female subject; but this discrimination would not to a general observer be easy. The pelvis, however, differs so considerably in its general contour according as it belongs to the male or female subject, that an observer must be careless indeed who is unable to discriminate the sex. The breadth of the female pelvis has reference to the peculiar characteristics, and functions of maternity, which need not be further adverted to.

Glancing downward from the pelvis, we perceive the various bones which go to the formation of the lower extremities. Observe here the beautiful articulation of the femur, or thigh-bone, with the pelvis: what a complete ball-and-socket joint it forms, and what freedom of motion is permitted! Observe, too, the line of direction of the femur; not a vertical line, which arrangement would expose the trunk to all manner of destructive shocks; but a diagonal line, the upper portion of the femur looking outward, and the lower portion inward, in such a manner that the knees of a skeleton appear to be placed much closer together than they give the impression of, in the living subject.

Passing downward in the direction of the foot, we have next to pay attention to the construction of the knee-joint, which is composed of three bones, and various cartilages, also a delicate membrane lubricated by a sort of oil profusely supplied, and termed "synovia; it is with the bones of the knee, however, that we are exclusively concerned at the present time. In front of the knee is a concave shell-like bone, vulgarly known as the knee-pan, or knee-cap, but termed by anatomists the "patella." The two remaining bones which form the knee are the tibia and fibula; being indeed, the two leg-bones. The leg is composed of two bones rather than one, chiefly because of the greater space given for the insertion of muscles; there is, however, some slight motion between the tibia and fibula, though very little. The foot is composed of no less than twenty-eight bones; namely, seven bones in the tarsus, five in the metatarsus, fourteen phalanges, and two disconnected bones called "sesamoid." If the bony structure of the foot be examined, it will be seen to constitute an arch; which formation not only imparts a spring-like quality to the lower extremity, thus diminishing the violence of shocks, but the arch is the strongest of all forms that admit of being constructed with a given quantity of materials.

What are the principal bones of the upper extremities?

It is necessary that the arms should have far greater freedom of motion than the legs; hence their bones are constructed and arranged on a different type. Instead of a rigid, bony mass, like the pelvis, the shoulder, or rather the bones which constitute it, are movable. Firstly, the bladebone, or scapula, is conspicuous by its flat triangular form, enabling it to slide over the posterior aspect of the ribs. Then there is the clavicle, or key-bone, known popularly as the "collar-bone," attached by its outer extremity with the "bladebone," and by its inner extremity to the upper division of the "sternum" or breastbone. Simple inspection will demonstrate the amount of motion of which the bladebone and clavicle, viewed collectively, are susceptible; but the extremely free movements of the upper arm are chiefly provided for by the articulation of the humerus, or bone of the upper arm, with the clavicle. The articulation in question is a ball-and-socket joint, the socket of which is extremely shallow, so that a wide extent of backward, forward, lateral and rotatory motion is imparted to the arm. This extreme freedom of motion, however, is given at the expense of stability; hence, dislocation of the shoulder is an accident of far more frequent occurrence than dislocation of the hip-joint.

As in the case of the lower extremity, it will be seen that the upper arm is composed of one single bone, *i. e.*, the "humerus," whereas the forearm has two bones. It will also be seen that the two bones which constitute the forearm are endowed with a large amount of rotatory motion, otherwise the hand would be very ill adapted to the numerous purposes of which it is now capable. Were it not for this power of rotatory motion subsisting between the radius and ulna (the names of the bones of which the forearm is composed), the hand would have been a clumsy, rigid member. It might have been planted on the extremity of the fore-arm so as to look upward, or downward, outward or inward; but, in whatever direction planted, there, a fixture, it must have remained. By the beautiful contrivance, however, of the rotation of the radius on the ulna, all this rigidity is obviated.

Will you describe the hand?

Each hand consists of twenty-seven bones, which are divided into three series, of carpal bones, metacarpal bones, and phalanges. Of these the carpal bones, together with the radius, form the wrist-joint; the metacarpus forms the palm of the hand, and the phalanges the fingers.

What are the bones of the Head?

The bones of the head, if we reckon the teeth and four little bones which exist in the ears, are no less than sixty-two in number: what may be termed, however, the bones proper of the head are twenty-two in number. Those in their turn admit of division into bones of the skull, and those of the face. If the bones of a young child's head be examined they will be found to be actually separated from each other; but as the child grows into the adult the bones join by a dove-tailed contrivance suggestive of the mode in which the parts of cabinet-work are put together: these junctions are termed "sutures."

What is the composition of Bone?

If a bone, no matter from what animal or from what part of an animal, be inclosed in a vessel capable of withstanding fire, and strongly heated until no more volatile matter comes away, the solid which remains behind will be found to have preserved the shape and contour of the original bone; but it will be black, and will have the appearance of a piece of charcoal: in point of fact, a considerable portion of it is charcoal, and may be purchased under the name of bone-black. Quite certain is it, therefore, that carbon, or the matter of charcoal, must be a constituent of bones.

Nevertheless, that the whole of the black substance thus resulting is not charcoal, is abundantly testified by the following simple operation: if, instead of inclosing a bone in a fireproof vessel as just described, it be burned in an open fireplace, air being freely admitted, all the carbonaceous or charcoaly portion is removed, and a white mass, still retaining the form of the original bone, remains. To this white mass we may apply the designation "*bone-earth*," reserving a description of the exact chemical nature of this bone-earth until hereafter. Quite certain is it therefore that bones contain not only carbon, or the matter of charcoal, but also what we have agreed to term bone-earth; and also a certain material, or materials, which pass away in the state of a volatile product.

If a bone be immersed in weak muriatic acid until nothing more is dissolved, all the bone-earth is removed, and an elastic gelatinous mass, still retaining the original form of the bone, remains. This white gelatinous material is, in point of fact, gelatine; if boiled in hot water, it dissolves, and forms a thick, colorless soup, very much resembling that which results from the solution of isinglass in water. Now this gelatine may be, in general terms, described as a compound of the volatile materials which are evolved when bone is burned in a close vessel, and carbon, or the matter of charcoal.

It will be perceived, then, that bone is made up of two proximate principles—one bone-earth, the other gelatine; on the due apportionment of which the strength of bone depends, also the adaptation of bones to their numerous uses. Bone-earth imparts hardness and rigidity, whilst the quality of elasticity is given by gelatine. Had they been exclusively composed of bone-earth, they would have been continually breaking; but had they, on the contrary, been made up exclusively of gelatine, then our limbs would have doubled together, deprived of all their strength.

Now, it must be remembered that the bones, like every other part of the body of animals, are made up of elements supplied to them by the blood, and the blood in its turn derives its constituents from the food we eat. If our food were to be altogether deprived of the matter of bone-earth, the bones would be devoid of this material; upon an appreciation of which fact depends a very important physiological principle.

Every person must have noticed the fact that children and young people bear falls and blows much better than grown-up persons. The bones of children are very seldom broken; and when this accident does occur, reparation is soon made. The bones of old persons, however, are fractured by the slightest possible causes; not unfrequently by the act of turning suddenly in bed. The difference between the two cases arises from the difference in the relative amount of gelatine and bone-earth in the bones.

Notwithstanding, however, that it is for a wise and benevolent purpose that the skeleton of young people is more cartilaginous than obtains in after-years, this condition of softness may proceed to extremes, and a disease may result, to which the name of rachitis, or rickets, is given. The disease is characterized by a preternatural softness of the osseous tissue, a further consequence of which is crookedness of the bones - which, hardening whilst they are still crooked, permanent deformity results.

What is the mechanical structure of Bones?

It is an unvarying principle of nature to produce effects with the least possible expenditure of material consistent with the amount of strength required — nothing being vainly given or thrown away. This principle is admirably illustrated in the formation of the bones. In some cases —as, for example, the bones of the head strength is imparted by fashioning them into peculiar arches or curves. In the structure of the foot, by which the whole weight of the body has to be supported, strength is given less by the configuration of each individual bone than by the method of building them together; and in the large bones of the extremities material is saved and strength secured by excavating the centre of the bone, and filling it, in terrestrial animals, with marrow. To birds this lightness of bone, consistent with strength, is of greater importance still; not only do these creatures require to have bones which are exceedingly strong, in order that the enormous strain upon them may be borne, but increased weight would interfere with the necessities of aerial locomotion; accordingly, not only is the material of the bones of birds exceedingly compact, and the walls of the cylinder very thin, but the central space, for the most part, contains nothing more substantial than atmospheric air.

What are Muscles?

A very large portion of animal bodies is made up of the material to which the term flesh, in ordinary language, is applied, but which, in the language of anatomy, is called "muscle." This is the substance which, by its contraction, gives rise to movements, and is therefore a very important part of animal bodies. The structure of muscle is fibrous; even by the naked eye these fibres may be seen, and when examined microscopically the intricate nature of the fibre is rendered evident. Casual observation might suggest the notion that muscle, or flesh, is composed of masses irregularly formed. This is not so, however; its material being fashioned into definite individual shapes, to each of which some specific anatomical name is applied. The cause of muscular motion is not known; and, although many theories have been advanced respecting it, none of them are worthy of adoption.

Muscles are usually attached to the bones by means of tendons, in which they both commence and terminate; they are held in position by sheaths, and their tendons are frequently imbedded in grooves. In proportion as muscles are used, so do they become strong and well developed. This result may be seen in the persons of those who are especially devoted to one pursuit and occupation. Blacksmiths and gold-beaters have the muscles of the right arm enormously developed. In dancers it is the muscles of the legs which increase in size, those of the upper extremities being puny and insignificant. The exercise of fencing causes an extraordinary increase of the muscles of the right arm and left leg, as being those most called into operation by that particular exercise. Very few movements have the advantage of exercising all the various muscles equally. Some act inordinately on one set, some on another. The object of well-devised gymnastic exercises is to bring all the various muscles into due operation; hence gymnastics should be regulated by some person conversant with the structure and requirements of the human body.

Will you describe the Brain and Nerves?

When the physiologist desires to learn the most general form a particular organ, tissue, or substance can assume, he frequently has recourse to comparative anatomy, and sees how the part or organ in question is dealt with in various animals. In man we speak with propriety of the brain and nerves, seeing that there is a wide distinction, as to locality at least, between the two. As to the brain, it is protected in a strong bony case; whereas the nerves ramify all over the body, for the most part protected as to their trunks, whilst their delicate terminations alone are expanded to receive impressions. In some of the lower animals it is otherwise, the brain and nerves forming one network; and, indeed, in certain animals lower still, the nervous matter is not collected in threads or masses at all, but is distributed all over the body. The nerves of an animal appear like small white threads; but the true physiological notion connected with a nerve is more complex than the mere appearance of the latter would seem to warrant. Each nervous thread, though apparently homogeneous, is not so really, but is made up of different fibres, having different functions, which fibres are merely formed into one thread, because they all happen to be travelling in the same direction.

Considered according to their anatomical appearance, nerves admit of being divided into nerves which are connected with the brain and spinal marrow, and nerves which are not. To the former class belong nerves of sensation and motion; also a third variety, of the nature of which it is not quite easy to give a popularly intelligible description in few words—nerves of the reflex function. The nervous system not in communication directly either with the brain or the spinal marrow is called the sympathetic system, the nerves belonging to which neither preside over sensation nor motion, but impart the necessary vigor to the stomach and other viscera. The two classes of nerves most distinctly recognizable as to their functions by the non-professional reader are the nerves of sensation and those of motion. The former are divided into nerves of special and of common sensation. The term special sensation will be seen to be appropriate to those ministering to the special functions of vision, hearing, smelling, and tasting; the remaining nerves of sensation are those which minister to the common sense of touch—a sense not denied to any soft external portion of the body, but more developed in some than in others. In human beings the sense of touch is most delicate in the tips of the fingers and the tip of the tongue. In the elephant, however, the extremity of the proboscis is the part where the sense of touch most prominently resides, and in the cat tribe the part of the face whence grow those long whiskers wherewith these animals are provided. It is a common notion that whiskerless cats are unable to smell. This is an error; they can smell well enough, but they are unable to feel.

The fact may appear strange, that although the functions of the nerves are so various—some ministering to one sense, and some to another—some being devoted, like so many wires of the electric telegraph, to the sending of messages that such and such thing may be done forthwith, that such and such motion may be made—the fact may appear strange, I say, that all these nerves should be connected with the brain and its sort of offshoot, the spinal marrow. Practically, however, it is wrong to regard the nerves and brain and spinal marrow after this fashion. Although the brain and spinal marrow are apparently, viewed in the aggregate, one mass of nervous substance, yet, in point of fact, their anatomy, no less than their physiology, is far more complex. As a great deal of nervous substance is necessary to the purposes of our bodies, and as, moreover, this nervous matter, being exceedingly delicate, has to be protected, nature has thought proper to protect it by a hard, bony case; nevertheless, it does not by any means follow that the brain is not a collection of—if the expression may be allowed—several smaller brains, each having a function of its own. This latter remark is suggestive of the doctrine of Gall and Spurzheim, subsequently denominated phrenology. That some connection does exist between certain shaped skulls, and corresponding traits of character, mental tendencies, or mental peculiarities, is a fact too unquestioned for comment.

What is Blood; will you describe its composition?

All animals possess a circulating fluid, to which the term blood may be applied; though in certain of the lower forms of animated beings the material is no longer red. A large portion of blood is water; in addition to which there are the proximate principles, fibrine and albumen, certain fatty and odorous matters, and red globules, possessing different form and different size for each animal species, and perhaps for each individual of the same species, though the latter point has not been well demonstrated. About one-fifth of the total weight of the human body consists of blood; whence it follows, that a human adult of average size will contain from thirty to forty pounds, or thereabouts, of blood. Blood is the direct source from which the waste of all the bones and organs is made up; hence the term commonly given to it, "vital fluid," is somewhat appropriate.

What is the Coloring Matter of Blood?

I have already mentioned that iron is found in the blood.

It is found, moreover, chiefly in the coloring matter of the blood, from which circumstance the idea does not seem at all improbable which attributed the coloring matter of the blood to iron. Every person knows what is meant by the red stain called *iron-mould*; every person knows that rust of iron is red; and chemists are aware of numerous iron compounds of which red is the prevailing color. Nevertheless, with all these facts before us, facts which seem to point beyond doubt to iron as the constituent which imparts to blood its characteristic redness, this deduction is by no means placed beyond doubt. On the contrary, one chemist, at least, maintains that he has separated the red matter of the blood from all other principles, and that he finds it to be altogether free from iron. Thus the matter rests.

Will you describe more particularly the meaning of some of the terms you use; what are Ligaments?

Close-compacted fibrous substances, serving to join two bones together. A ligament is more flexible than a cartilage, and is not easily ruptured or torn.

What are Cartilages?

Smooth, white substances, harder than are the other solid parts of the body, except the bones. They possess a very high degree of elasticity, which properly distinguishes them from all other parts of the body. They compose the external ear, and external aperture of the nostrils and eyelids; the larnyx is formed entirely of this substance. The bodies of the vertebræ are joined by large masses of a peculiar substance partaking of the properties and appearance of cartilage and ligament, which imparts great elasticity to the spine, by which the effects of concussion from jumping, falls, etc., are weakened and destroyed before they can reach the head.

What are Membranes?

Expanded substances of a pliable nature, and fitted to serve as coverings for other parts of the body, as the skin, pleura, etc.

What are Arteries?

The tubes which convey the blood from the heart to the various parts of the body, where they terminate in veins, which return it back to the heart. By the circulation of the blood through the arteries is produced the particular motion called the pulse, which arises from the alternate dilatation and contraction of the arteries. To the illustrious Harvey the merit is attributable of demonstrating the circulation of the blood. He was led to this discovery by reflecting on certain mechanical appearances presented by the veins of animals. That the veins contained blood in living animals was a fact known from the most ancient times, but the function of the arteries was a mystery. After death these latter vessels are usually found empty; they were, therefore, presumed by the Alexandrine anatomists to contain air; whence indeed the name "artery" was derived. Harvey noticed that the veins were provided with valves, opening in one direction, so that the blood could only flow through the veins in the direction from the ramifications to the large trunks. As for the arteries, he noticed that they were devoid of this valvular structure; and he proved by ingeniously-devised experiments, that the blood must be carried from the heart by means of the arteries, and must be returned to the heart through the channel of the veins.

Will you describe the Circulation of the Blood?

The functions of digestion, circulation, and respiration are so intimately connected, that it is difficult to treat of them distinctively—I therefore propose to discuss them together. When the food has been masticated and taken into the stomach, the process of digestion commences. By the solvent agency of the gastric juice, which is poured out in abundance as soon as food is swallowed, the ingesta are dissolved and converted into a semifluid state; it then passes out of the stomach into the duodenum, where it mingles with the bile and pancreatic juice. The bile, by the exercise of some chemical agency, causes the digested matter to separate into two portions: one excrementitious, and the other nutritive; the latter, termed chyle, is taken up by a multitude of small vessels called absorbents. The chief of these chyle-absorbing vessels is termed the thoracic duct. Let us follow the course it takes: the thoracic duct leads directly from the duodenum to a large vein—the left subclavian vein—where mixture between the chyle absorbed and the blood of the vein is effected. The left subclavian vein transfers its mixture of blood and chyle to a vein larger than itself, and the latter conveys it directly to the heart. The heart consequently next demands our attention. Though the heart appears, on a casual examination, to be one organ, its function is really double; and, physiologically speaking, each individual of us may be said to have two hearts. They are placed closely together, it is true, and invested by one envelope. This is a convenient arrangement, merely; but the heart is as really bipartite, and its functions are as markedly double, as if the two functional parts had been situated respectively on either side of the body.

Corresponding with this twofold division of the heart is there a double circulation?

Yes; one portion of the heart is concerned in projecting impure blood into the lungs to be purified, and receiving it back again; whilst another portion has for its function the distribution of purified blood throughout the body, and its reception back again. Let us examine with greater minuteness how these circulations are effected.

Reverting to the thoracic duct, thence to the left subclavian vein, and the large venous trunk which the latter joins, and following the course of venous blood, we at length arrive at the smaller of the two cavities on the right side of the heart. It is called the right auricle; and all the blood which it receives is dark-colored and impure, standing in need of the influence of atmospheric air for its regeneration. From the right auricle the blood now passes into the larger of the cavities on the right side of the heart, and to which the term right ventricle is applied. The walls of the cavity are thick and strong, made up of muscular fibre, and the orifice which permits the entrance of blood from the right auricle into the right ventricle is protected by a valve which only enables the blood to pass in one direction; it cannot return to the right auricle by the way it departed from the latter.

Having followed the blood into the right ventricle, it is forced, by contraction of the latter, into a large vessel called the pulmonary artery—called pulmonary because it proceeds to the lungs, and differing from every other artery in containing dark-colored blood; one main branch goes to each lung, and divides into extreme minuteness, and terminates in the capillaries, which are arranged in the most delicate network on the surface of each cell. In its passage through these, the impure or *venous* blood undergoes the chemical change due to respiration; it resumes the qualities of red or arterial blood, and is returned into the left auricle of the heart, and thence into the left ventricle, from which it is passed into general circulation as before. The blood which is returned from the veins is called *venous*; that which leaves the heart is red, and is called *arterial*.

Will you describe the lungs and their functions?

The lungs are situated in the chest, and are divided in two parts, called lobes. They are enveloped in a delicate and transparent membrane, through which they have the appearance of network, and are connected with the spine by the pleura, with the neck by the windpipe, and with the heart by the roots of the pulmonary artery and veins. To the touch they are soft, spongy, and elastic. They are composed of an infinite number of membraneous cellular blood-vessels, nerves, and lymphatics, all connected by other cellular substances. In their specific gravity they are the lightest of all the animal organs, even when exhausted of air; hence their name of *lights*.

How is the purification of the blood in the lungs effected?

Although the blood is purified in the lungs by the atmospheric air which is conveyed there to that end, the air and the blood are never brought into absolute contact. To explain in what manner this purification takes place, it will be necessary to preface a few remarks concerning the functions of endosmose and exosmose, or, more simply speaking, the power of transmission of fluids and liquids through membranes.

To illustrate this curious property, the following simple experiment may be adduced; it requires no expensive apparatus or delicate manipulation; it may be performed by any person:—

Let a glass tumbler be taken and filled with treacle; then let a piece of bladder be firmly strained over the tumbler, and securely tied; this being done, let the glass be completely immersed in a vessel of water, and allowed to remain. After the lapse of some hours the bladder will be seen to bulge outward, proving that the bulk of material inside the tumbler must have increased. Now, inasmuch as the treacle has no innate power of expansion under the treatment presupposed, the increase of bulk can only have arisen from the entrance of a portion of water. Further examination demonstrates this assumption to be correct—demonstrates, moreover, that the permeation of the membrane has not been all in one direction; not only does a portion of water pass inward, but a portion of treacle passes outward; but, inasmuch as the bulks are not equal, there is a bulging outward of the membrane, as already described.

The example just mentioned is one displaying the functions of endosmose and exosmose as between two liquids. The same functions are also exercised between two gases, and one of the functions may be exercised under certain conditions between a fluid and a gas; that is to say, a gas may permeate a membrane to arrive in contact with a liquid, but liquids cannot or do not usually permeate a membrane to come in contact with a gas.

Without going further into the phenomena of endosmose and exosmose—a consideration which would soon involve us amongst the laws of gaseous diffusion—enough will have been stated to indicate in what manner black venous blood may be purified in the lungs by the influence of atmospheric air without any bodily contact between the two. It is purified by undergoing a sort of combustion; the venous blood is highly charged with carbon, and the oxygen of the atmosphere, operating as we have seen, burns away, as it were, this impure element of the fluid.

Is the circulation of the blood rapid?

Astonishingly so; did it flow at an equal rate in a straight line, it would run in the space of one minute through about one hundred and fifty feet. This swiftness, however, exists only in the larger vessels near the heart; the further the blood recedes from the heart, the slower its motion becomes. By what means the blood is made to penetrate the thousand windings of the capillary system, and what causes impel it to flow back through the veins, are yet subjects of dispute among physiologists.

About the Atmosphere.

What is Atmosphere?

The fluid or gas which surrounds the earth, one of the most essential appendages to the globe we inhabit.

Of what is it composed?

It is ascertained to be a compound substance, formed chiefly of two very different ingredients, termed oxygen and nitrogen gas.

What are the relative proportions of these gases?

Of one hundred measures of atmospheric air, twenty-one are oxygen, and seventy-nine nitrogen. The one, namely, oxygen, is the principle of combustion. It is absolutely necessary for the support of animal life, and is one of the most important substances in nature. The other (nitrogen) is altogether incapable of supporting either flame or animal life. But the term atmosphere is also applied to the whole mass of fluids, consisting of air, vapors, electric fluids, and other matters which surround the earth to a certain height. This mass of fluid matter gravitates to the earth, revolves with it in its diurnal rotation, and is carried along with it in its course round the sun every year.

How far above the surface of the earth does the atmosphere extend?

It has been computed to extend about forty-five miles above the earth's surface, and it presses on the earth with a force proportioned to its height and density. From experiments made with the barometer, it has been ascertained that it presses with a weight of about fifteen pounds on every square inch of the earth's surface; and, therefore, its pressure on the body of a middle-sized man is equal to about thirty-two thousand pounds, or fourteen tons avoirdupois, a pressure which would be insupportable, and even fatal, were it not equal on every part, and counterbalanced by the spring of the air within us.

The pressure of the whole atmosphere upon the earth must be very great.

It is computed to be equivalent to that of a globe of lead sixty-six miles in diameter; in other words, the whole mass of the air, which surrounds the globe, compresses the earth with a force or power equal to that of five thousand millions of millions of tons. This amazing pressure is, however, essentially necessary for the preservation of the present constitution of our globe, and of the animated beings which dwell on its surface. It prevents the heat of the sun from converting water and all other fluids into vapor; and preserves the vessels of all organized beings in due tone and vigor. Were the atmospherical pressure entirely removed, the elastic fluids contained in the finer vessels of men and other animals would inevitably burst them, and life would become extinct; and most of the substances on the face of the earth, particularly liquids, would be dissipated into vapor.

What other properties does the atmosphere possess?

Numerous admirable and indispensable ones, of which the following may be mentioned. It is the medium of odors, or smells, by which we become acquainted with the qualities of the food which is set before us, and learn to avoid those places which are damp, unwholesome, and dangerous. It is the medium of sounds, by means of which knowledge is conveyed to our minds. Its undulations, like so many couriers, run forever backward and forward, to convey our thoughts to others, and theirs to us, and to bring news of transactions which frequently occur at a considerable distance. A few strokes on a large bell, through the ministration of the air, will convey signals of distress, or of joy, in a quarter of a minute, to the population of a city containing a hundred thousand inhabitants. It transmits to our ears all the harmonies of music, and expresses every passion of the soul; it swells the notes of the nightingale, and distributes alike to every ear the pleasures which arise from the harmonious sounds of a concert. It produces the blue color of the sky, and is the cause of the morning and evening twilight, by its property of bending the rays of light, and reflecting them in all directions. It forms an essential requisite for carrying on all the processes of the vegetable kingdom, and serves for the production of clouds, rain, and dew, which nourish and fertilize the earth. In short, it would be impossible to enumerate all the advantages we derive from this noble appendage to our world.

Were the earth divested of its atmosphere, what would be the consequence?

Should the earth be deprived of the atmosphere, or even two or three of its properties changed or destroyed, it would be left altogether unfit for the habitation of sentient beings.

Were it divested of its undulating quality, we should be deprived of all the advantages of speech and conversation, of all the melody of the feathered songsters, and of all the pleasures of music; and, like the deaf and dumb, we could have no power of communicating our thoughts but by visible signs. Were it deprived of its reflective powers, the sun would appear in one part of the sky, of a dazzling brightness, while all around would appear as dark as midnight, and the stars would be visible at noon-day. Were it deprived of its refractive powers, instead of the gradual approach of the day and the night which we now experience, at sunrise we should be transported, all at once, from midnight darkness to the splendor of noon-day; and, at sunset, should make a sudden transition from the splendors of day to all the horrors of midnight, which would bewilder the traveller in his journey, and strike the creation with amazement. In fine, were the oxygen of the atmosphere completely extracted, destruction would seize on all tribes of the living world, throughout every region of earth, air, and sea.

You allude to the Barometer; what is it?

An instrument for ascertaining the weight of the atmosphere and also for indicating the approaching changes in the weather according to the variations in the pressure of the atmosphere. It consists of a narrow glass tube, upward of thirty inches in length, open at one end and closed at the other. This tube contains quicksilver; and when the pressure of air on the open surface increases or decreases, the quicksilver falls and rises responsively.

The phenomena of the common pump were long explained by the maxim that "nature abhors a vacuum;" but in the time of Galileo the pump-makers at Florence found that water would not rise higher than thirty-two feet. They applied to Galileo for a solution of the problem, but the great philosopher was then in extreme age, and he does not seem to have discovered the true cause of the phenomenon; but upon his deathbed he urged his pupil Torricelli to pursue the investigation of the subject. This he did, but it remained for Pascal to complete the important discovery, who proved that the mercurial column of the barometer was indeed supported by atmospheric pressure, from the fact of being affected by the variations of the superincumbent air in accordance with relative degrees of altitude. Observations made upon mountains, church-steeples, etc., all confirmed the fact, that the mercury in the tube varied with undeviating certainty; hence the barometer became an important instrument for measuring the height of mountains, or the relative altitude of places above the surface of the earth.

About Electricity.

What is Electricity?

The word electricity denotes a peculiar state of which all bodies are susceptible, and which is supposed to depend upon the presence of a substance called the electric fluid. Some of its phenomena were known to the ancients, particularly those attractions and repulsions which a piece of amber, after being rubbed, exhibits, with regard to hairs, feathers, and other light bodies; and this power afterward came to be called electricity, from *electron*, the Greek word for amber. Thales, who lived six centuries before the Christian era, was the first who observed the electrical properties of amber, and he was so struck with the appearances, that he supposed it to be animated. Mr. Boyle is supposed to have been one of the first persons who got a glimpse of the electrical light, or who seems to have noticed it, by rubbing a diamond in the dark. Sir Isaac Newton was the first who observed that excited glass attracted light bodies on the side opposite to that on which it is rubbed.

Does this peculiar quality belong to other substances?

Yes; an electric is any substance which being excited or rubbed by the hand, or by a woollen cloth, or other means, has the power of attracting light bodies. If a piece of sealing wax be rubbed briskly with the sleeve of your coat, a silk handkerchief, etc., for some time, and then held near hair, feathers, bits of paper, or other light bodies, they will be attracted; that is, they will jump up and some of them will adhere to the wax. If a tube of glass, or small phial, be rubbed in a similar manner, it will answer much better. If this operation be performed in the dark, something luminous will be seen, which is called the *electric matter or fluid;* and all bodies that we are acquainted with have more or less of it in them; though it seems to lie dormant till it be put into action by rubbing. The air, and every thing, is full of this fluid, which appears in the shape of sparks; the rubbing of the glass with the hand collects it from the hand; and the glass, having now more than its natural share, parts with it to any body that may be near enough to receive it.

What is the distinction between the substance rubbed and that with which it is rubbed?

They are always found to be oppositely electrified—the one body having more and the other less than its natural share. Indeed, one kind of electricity is never obtained without at the same time the production of the other. Those bodies which have been called electrics, will not convey electricity from one body to another, and therefore they are termed non-conductors.

Will you name the non-conductors?

The most remarkable are glass, and all vitreous substances, precious stones, resins, amber, sulphur, baked wood, wax, silk, cotton, wool, hair, feathers, paper, white sugar, air, oils, metallic oxides, all dry vegetable substances, and all hard stones, Those bodies, which, when rubbed ever so much, do not exhibit electricity, are called non-electrics. They convey electricity from one body to another, and therefore are denominated conductors; they are as capable of having electricity developed upon them by friction as those bodies which have been called "electrics," but it is conducted away as fast as it is produced. Some of them conduct electricity much better than others. The principal conductors are the metals, charcoal, all fluids except dry airs and oils, most saline substances, and stony substances. Woollen and silk, when wet, will, by means of the water, conduct electricity.

When a body has more than its natural quantity of this fluid, it is said to be electrified positively, or *plus;* and when it has less than its natural quantity, it is said to be electrified negatively, or *minus*. When bodies are electrified in either of these ways, they repel each other; but if some be electrified *plus*, and others *minus*, they mutually attract; or if one body be electrified plus, and the other not electrified in either way, they also attract each other.

Are there not some animals that possess a peculiar electric power? What is the electric Eel?

Yes; there are some fishes which possess the extraordinary faculty of being able, at pleasure, to communicate shocks like those of an electric battery or galvanic pile, to any animal that comes in contact with them. They are called the *torpedo*, the *Gymnotus electricus*, and the *Silurus Indicus*. The most remarkable of these is the *Gymnotus electricus* or *electric eel*, which is frequently found in the marshes and stagnant pools of Guiana, and other countries of South America. The shocks they give are exceedingly severe; and Humboldt mentions a road which has been totally abandoned, because the mules in crossing a wide ford, were, by these violent attacks, often paralysed and drowned. Even the angler on the bank was not exempt from danger, the shock being conveyed along his wetted rod and fishing line. The electric eel is sometimes twenty feet long. The electricity of all those fishes is exerted by them only when they please, and of course only while they are alive. After the animal has discharged its electrical matter, the next shock is weaker; and when the animal is exhausted, it has lost all the power of producing any effect for some time.

What was Franklin's discovery in reference to electricity?

The identity of the electric spark and atmospheric lightning and thunder, the resemblance between which struck him with so much force that he determined to test the matter by experiment.

Having constructed a kite by stretching a large silk handkerchief over two sticks in the form of a cross, on the appearance of an approaching storm he went into a field in the vicinity of Philadelphia, and raised it, taking care to insulate it by a silken cord attached to a key, with which the hempen string terminated. No sooner had a dense cloud, apparently charged with lightning, passed over the spot on which he stood, than his attention was arrested by the bristling up of some loose fibres on the hempen string. He immediately presented his knuckle to the key, and received an electric spark. His emotion at this discovery was intense. The rain now fell in torrents, and, wetting the string, rendered it a conductor throughout its whole length, so that electric sparks were now collected from it in great abundance. The discovery of Franklin soon engaged the attention of all the philosophers of Europe, and the truth of the theory that lightning and electricity are the same fluid was put beyond all question.

What is Galvanism?

A branch of electrical science, which took its origin about the close of the last century from a trivial circumstance which occurred in the house of Signor Galvani, an Italian philosopher, from whom the science has derived its name. A recently-killed frog, having been accidentally touched in the limb with the blade of a knife which was held by a person who was experimenting with an electrical machine, was immediately thrown into violent convulsions. Galvani, who was not present, was informed of the circumstance, and he lost no time in repeating the experiment. He found that other metals beside steel answered the purpose; that they owed this property of exciting muscular contractions to their being good conductors of electricity. Galvani proceeded with his experiments, and arrived at the conclusion that the different parts of an animal are in opposite states of electricity, and that the effect of the metal is merely to restore the equilibrium.

Was this conclusion correct?

No; the theory was found to be erroneous by Professor Volta, of Pavia, who, setting out with the idea that the electricity did not belong to the animal, but to the different metals employed, was led to the discovery of what we now term the *Voltaic battery.* In meditating upon the development of electricity at the surface of contact of two different metals, he tried the effect of his compound plates of metals upon animals, and was led to infer that the electricity was derived, not from the living system, but from the action excited between the metal and the humid animal fibre; that the animal matter acts merely as a medium conducting this electricity. He further discovered that the metallic plates which he used, such as silver and zinc, are excited—the former negatively, and the latter positively; and, also, that the galvanic energy could be augmented by employing several pairs of plates, connecting them in such a manner that the electricity excited by each pair should be diffused through the whole; and this constituted the voltaic pile. From these experiments it became apparent that electricity could be produced from the action of two different metals immersed in a suitable menstruum, and in some manner connected with each other.

Can you explain more particularly the construction of the Voltaic Battery?

If plates of zinc and of silver, or of zinc and copper, and pieces of woollen cloth of the same size, moistened with water or diluted acid, be piled upon each other in the order of zinc, copper, cloth, zinc, copper, cloth, and so on for about twenty repetitions, you have the voltaic pile. The following experiments may now be performed:—

Having wet both hands, touch the lower part of the pile with one hand, and the upper part with the other; a slight shock of electricity will be felt as often as one hand is removed. If the hand be brought back, a similar shock will be felt. Put a basin of water near the pile, and put the left hand into it, holding a wire, the one end of which touches the top of the battery or pile; then put the end of a silver spoon between the lip and the gum, and with the other end of the spoon touch the lower part of the pile; a strong shock is felt in the gum and in the hand. Take the left hand from the water, but still keep hold of the wire, and then perform the last experiment in the same manner, and a shock will be felt in the gum only. Hold a silver spoon in one hand, and touch with it the battery at the lower part, then touch the upper part with the tongue, the bitter taste is extreme.

Is the Battery a combination of these voltaic piles?

The apparatus best adapted for experiments is what is called a trough—an open box of wood well joined together, and secured from leakage by being lined with some kind of resinous material or pitch. The plates of zinc and copper are placed in the trough vertically, in the order as described; the end plates have connecting wires; and when the trough is filled with water impregnated with nitric or muriatic acid, and the points of the wire brought together (one of which represents the positive, and the other the negative pole of the electricity), the action is remarkably powerful. When several of these troughs are connected together, the apparatus is called a *battery*.

Will you now explain the Electric Telegraph?

The electric telegraph is one of the most important results that have as yet arisen from the discovery of galvanism and electro-magnetism.

What is Electro-magnetism?

I have already, in the chapter on metals, explained the nature of the magnet. Electro-magnetism is the name applied to a very interesting class of facts recently discovered in reference to the magnet, by which the power of destroying and reversing the polarity of a magnet, and of communicating magnetic influence to iron not previously magnetic, has been developed.

Now, if we take a magnetic needle, such as I have described, and suspend it vertically on an axis passing through its centre, and then, by means of a wire, pass a current of electricity around it from a battery such as I have just described, the needle will take up a new position at right angles to that which it maintained before. Whether the upper point, or north pole, of the needle moves to the right or left in order to attain this position depends on the direction of the current. Thus we have arrived at the principle of an electric telegraph. We have but to agree upon a set of signals that the deflection of the needle shall signify; and if we can contrive to send the current in the direction we wish, so as to move the north pole of the needle to the right or left at will, the apparatus will be complete. But in practice it is necessary that we should be able to move as we please a similar needle to our own, at the station to which we desire to send the message. In order to accomplish this, we have but to conduct the current from one station to the other by means of an insulated wire, which, passing from station to station, the wire in each instance conducts the currents around the needles having their north poles upward, deflects the needles in the same direction at the different stations, and, lastly, returns upon a continuous wire to the other or opposite pole of the battery from which it departed.

Formerly the current returned to the negative end of the battery by the same wire. But by a recent discovery the return wire is not necessary: for it has been found that if the end of the wire is buried deep in the ground, attached to a plate of metal, the earth itself would conduct the current back again—thus saving the cost of a return wire.

You have thus briefly a description of the principle of the telegraph. A clear conception of the instruments, the signals, etc., can scarcely be conveyed by description. Moreover, there are numerous modes, some of which operate by signals, others by letters; the more recent instruments are provided with keys similar to those employed upon the pianoforte, each key representing a letter of the alphabet.

What is the speed of Electricity?

That of light itself, 192,000 miles in the space of a second. In point of fact, no longer time would be occupied in transmitting intelligence to the uttermost ends of the earth than would be required for sending it across a room. Distance is a matter for consideration only as regards expenditure of galvanic force; and the time will come, no doubt, when the advances of science will render the transmission of currents between points the most remote without any appreciable consumption of time—a practical annihilation of space.

About Arts and Sciences.

What is Engraving; will you describe the process?

Engraving is described as the art of representing by means of lines and points, produced by means of cutting or corrosion, the figures, lights and shades of objects, in order to multiply them by printing. There are two widely distinctive styles: steel or copper plate engraving, and wood engraving. The earliest method practised was upon wood, which was known to the Chinese before the Christian era, but was not known in Europe until the middle ages, when it was introduced the intercourse of the Venetian merchants with the inhabitants of the Celestial empire. Engraving upon metallic substances was not practised in Europe until the first half of the fifteenth century, although it is probable that the art in this form was also known to the Chinese long before.

Are there not several varieties of Steel or Copper Engraving?

Yes; line, etching, stipple, mezzotinto. A steel plate is first softened by being deprived of a portion of its carbon, and after the engraving is made the plate is hardened again by the restoration of the carbon. The plate being thus prepared, the next process is to trace the design intended for engraving accurately upon the plate. The surface of the steel is covered with a thin coating of wax; the drawing is then copied in outline with a black-lead pencil on paper, which is laid with the pencilled side upon the wax, and transferred by pressure of the hand or a burnisher. The design is then traced with an etching-needle through the wax upon the plate; the wax is removed, and the plate exhibits the outline of the design ready for the graver. The graver is a steel instrument ending in an unequal-sided pyramidal point; the steel is inserted in a wooden handle convenient in size and form for the hand. With this instrument the process of *line* engraving proceeds; in cutting the lines the graver is pushed forward in the direction required, being held in the hand at a small inclination to the plane of the copper. These lines are then deepened or strengthened as required, and in this manner the work laboriously proceeds. Mechanical skill in maintaining true and perfect lines as well as taste and judgment in producing the effects of light and shade are indispensable qualities in the engraver.

What is Etching?

In etching, the plate is covered with a ground or varnish, usually composed of asphaltum, gum-mastic, and wax, which is capable of resisting the action of aqua fortis; the design is traced through the varnish upon the plate, and, when completed, a dilution of aqua fortis is poured upon the surface, which bites or eats the design into the plate. When this is accomplished, the wax is removed, and certain deficiencies which inevitably occur remedied by the graver. Etching is especially adapted to the engraving of trees, bark, foliage, rough ground, etc.; while figures, faces, etc., are produced in line.

What is Stippling?

Engraving in dots. The graver is used, but instead of lines, the effect is produced by minute points or excavations. It is a slow and laborious process, but in the softness and delicacy of its lights and shades it is much admired.

What are Mezzotintos?

This mode of engraving is said to have been discovered by Prince Rupert. It is the easiest and most rapid of all the modes of engraving upon metallic surfaces. In the first place, a uniform smooth black tint over the entire surface of the plate is procured by means of a knife, or what is called a grounding-tool, an instrument made for the purpose, which, being rocked backward and forward, the teeth of the tool equally and regularly indent the plate from side to side. Upon this mezzotinto grain, or ground, the design is now traced; and with a scraper and burnisher the artist proceeds with facility and ease; the lights of his picture are secured by obliterating or scraping away the ground-tint, and the shades obtained by leaving it. Engravings, by this process, are executed with great facility; the shades, which with line engraving are the heaviest and most laborious portion in the mezzotint, are absolutely procured before the design is commenced. The excellence of this mode consists in the richness of its shadows; its lights are defective.

What is the difference between wood and steel engraving?

In steel and copper engraving the lines are cut into the surface, but in wood engraving they are raised like the letters of printing types. The darks of steel engravings are obtained by cutting away the metal; in wood engraving t. darks are obtained by retaining the wood, while the lights are produced by cutting away the wood. The processes, as you see, are directly reversed. The wood used for wood engraving is box; it is cut to about an inch thick, and planed smooth. The design is drawn on the wood, and the engraver proceeds to excavate between the lines of the designer, cutting away the wood for the lights, and in the deepest shades scarcely engraving the surface at all. As the lights and shades in wood and metal engraving are obtained by processes so entirely distinct, there must obviously be different modes of printing them.

Will you explain the different modes?

Wood-cuts are printed the same as types; they can even be introduced into the page with letter-press. The surface is inked, and the impression taken in the ordinary way; but by processes of *overlaying* and *underlaying* the effect of wood-cuts very much depend. The shades are heightened and the graduations of shades more finely marked by thicknesses of paper pasted to the under surface of the block, and on the tympans (frames of stretched paper or muslin upon which the paper which is to receive the impression of the cut is attached), by which means the pressure can be so distributed as to heighten the shades or soften the lights according to the wishes of the printer.

In steel-plate printing the mode is as follows: the surface of the plate is covered with ink from a rubber made of linen rags. The plate being sufficiently inked, and the lines or excavations of the design thoroughly filled with ink, the surface of the plate is carefully wiped with the palm of the hand. To wipe the plate thoroughly clean, and yet not remove the ink out of the engraving, is the aim and skill of the workman. Over the plate thus prepared the moistened plate-paper is placed, and over the paper two or three folds of flannel. The whole is then subjected to the pressure of the press; the moistened paper is forced into the hollow lines of the engraving, whence it imbibes the ink, and produces the requisite impression. The process is slow, and, compared with woodcut printing, expensive.

What is Lithography?

Lithography (from *lithos*, a stone, in Greek) is an art by which impressions are obtained from designs made on stone. I have just described the differences between the mode of obtaining impressions from wood and steel engravings; the lithographic process differs from both these modes, the impressions being obtained (by strict attention to chemical affinity) from a level surface.

The stones used for lithographic purposes are a sort of calcareous slate found on the Danube in Bavaria; some of an inferior quality are obtained from England. The surface of the stone is polished with pumice-stone; and upon the surface thus prepared the design is made with lithographic chalk, and lithographic ink, composed of tallow, virgin-wax, soap, shell-lac, and lamp-black; the chalk is used in a mould, the ink is dissolved by being rubbed like Indian-ink in water, and is used in a pen or camel's-hair pencil.

With the chemical chalk the design is now made; after which a solution of vitriolic acid is poured upon the stone, which takes up the alkali from the chalk or ink, and renders them insoluble in water. The stone is now washed with water; but the water is imbibed by the stone only in those parts not occupied by the drawing, which being greasy repels the water and remains dry. A roller covered with printing-ink is now passed over the stone; the parts of the drawing being greasy have an affinity for the printing-ink and absorb the composition; but the wet portions will not be soiled, from the antipathy of oil and water. Damped paper is put over it, the whole is passed through the press, and the impression is secured.

There is a mode of transferring drawings made on paper prepared with a solution of size or gum-tragacanth, which being laid on the stone and passed through the press, leaves the drawing on the stone, and the impressions are then taken as described above.

Lithography is a modern invention. The merit of the discovery belongs to Aloys Senefelder, a musical performer at the theatre of Munich, about the year 1800.

What is Zincography?

A mode of engraving on zinc, very similar in principle to lithography.

A species of engraving on copper, called the *medallic*, is of recent invention. Its object is to give accurate representations of medals, coins, and bassi-relievi of a small size.

Will you describe the manner of printing lithographs and wood-engravings in colors?

The processes are the same as those I have described, excepting that for every color or tint in the design there must be engraved a separate block or stone; that is, all the yellow impressions of the picture must be printed at one time, and a drawing must be made of all those parts of the design in which yellow appears, from which the impression is made; another block must be made for blue, another for red, etc. Some tints and shadings are produced by lapping the colors. Of course the impression given by one stone or block must be exactly fitted into by the impression given from the next, and so on, until the whole subject is complete. Great skill and care is necessary in this kind of printing; but, to such perfection is the art already advancing, that in many instances prints from colors in oil have much of the richness, tone, and beauty of a painting upon canvas.

What is the Daguerreotype?

A mode of fixing upon a metallic plate the lights and shades of a landscape or figure solely by action of the solar light. The term is derived from the name of the inventor, M. Daguerre, of Paris. A plate of copper thinly coated with silver is exposed to the action of the vapor of iodine; it is then placed in the dark chamber of a camera-obscura, where an image of the object to be represented is cast upon it. It is then withdrawn, and exposed to the vapor of mercury, which brings out the impression with distinctness; it is afterward plunged into a solution of hypo-sulphite of soda, then washed in distilled water, and the process is complete. The *ambrotype* is the application to glass of the same principle as that involved in the daguerreotype, and for portraits is in some instances preferred. There are also Talbotypes, calotypes, halotypes, etc., which are simply variations of method in the use of the same agents, that have for their aim the chemical action of light on variously prepared surfaces. The experiments of chemists and artists, indeed, are continually developing new resources in this great art. In sharpness, color, precision, and other qualities, this new school of art is making rapid advances.

What is Photography?

Photography (light drawing), or heliography (sun drawing), is one of the most important applications of the discovery of Daguerre. Photographs are not taken upon plates, but upon prepared paper; for architecture, landscapes, views, they are specially adapted, and even for portraits they are superseding every other method. They do not possess the metallic glare of drawings upon plates, while in sharpness of outline and in clearness of effect, the daguerreotype is very much their inferior.

The photograph is obtained by two distinct processes. The first impression is called the negative, which exhibits all the light parts of the object of a dark color, and all the lights in the same way reversed; and the representation is also the reverse of the original in position. Formerly the negatives were taken upon paper, washed with a solution of the nitrate of silver, but the most recent mode is to take the negative upon glass, similarly prepared. Upon the face of the negative a sheet of photographic paper (albuminized paper it is called, being prepared from albumen and other chemical agents) is applied, and exposing both to the light, a copy is produced in which objects are brought into their true position, and the right effect of light and shade is obtained. Copies from the negative may be multiplied *ad infinitum;* the first great difficulty being to secure a good negative from the picture or object. Although photographs in single impressions are costly, where large numbers are required the facility of their multiplication, after the first impression is secured, renders them under such circumstances cheaper than when the pictures are obtained by any other process.

Are Photographs taken in color?

No; a great many experiments have been made to this end, but as yet not with full success. Mr. Hill, of Greene county, New York, has been asserted to have produced the colors of nature, but his success has only been partial, we believe, and some of the tints he still finds it impossible to reproduce. I do not doubt, however, but that in time the chemical secret will be discovered by which the tints and hues of nature, as well as her outlines, can be reproduced by that great artist, the sun.

What is the present mode of coloring?

The tinting is produced by the application of finely-powdered colors to the surface of the photographic impression, which is previously coated with an alcoholic solution of copal, and nearly dried; so that the coloring which is so delicately performed as not to impair the distinctness of the impression, is not in any degree the result of the action of light.

What is a Camera-Obscura?

The camera-obscura, or dark chamber, is an optical machine or apparatus, in which the light being collected, and thrown through a single aperture, external objects are exhibited distinctly on any white surface placed within the machine.

What is meant by Encaustic Painting?

Encaustic signifies executed by fire; but encaustic painting was an art employed by the ancients the method of which is uncertain. It appears that the colors were made up into crayons through a medium of wax, and the subject being previously traced with a metal point, were melted on the picture as they were used. A varnish of melted wax was applied to the entire surface of the picture when finished; the result was, not only colors of great brilliancy but remarkable durability, which remained unaffected by heat or water. The moderns have applied the term for painting on porcelain, and work in enamel, but the art as practised by the ancients has never been revived.

What is Fresco-Painting?

Fresco literally means *fresh*, and the term is applied to this kind of painting because it is executed upon a layer of fresh plaster. The colors, incorporated with the plaster before it is dry, become as permanent as the wall itself. Water-colors alone are used; great rapidity of execution is necessary, and also great knowledge of colors and great skill in drawing are indispensable, as the painting cannot be retouched. This art, which is employed generally for large pictures on walls and ceilings, was understood by the ancients, but first made of real importance by the Italians in the sixteenth century.

What are Cartoons?

Literally paper, or pasteboard, and denote in painting a sketch on thick paper to be used as a model for a large picture in fresco, oil, or tapestry. In fresco painting cartoons are particularly useful, the design being first sketched and then calked through and transferred to the fresh plaster. For purposes of tapestry, the figures drawn upon the cartoons are cut out, and laid behind or under the woof, by which the artist directs his operations. In this case the cartoons must be colored. Of this kind are those which Raphael executed for Pope Leo X., from which the famous tapestries of Raphael in the Netherlands were woven. Seven of these cartoons, the most celebrated in existence, are exhibited at Hampton Court Place, England. They were bought by Rubens for Charles I., and King William built a gallery for them at Hampton Court.

What is Pastel Painting?

Pastel, or *pastil*, is from the French, and means a kind of paste-pencil. The process is by crayons ground up with gum-water into a kind of paste, and applied with the stump to the surface of a prepared paper, not unlike fine sand-paper. The surface of the painting is sometimes touched or washed with oil. It is a style of painting recently come into vogue; but it has few recommendations, and its great defect is a want of durability.

What is Grecian Painting?

A mode of coloring engravings by which they have the appearance of oil-paintings, or more especially the resemblance of oil-paintings upon copper. Mezzotints and lithographs can only be made use of to advantage. The picture is stretched upon a frame, moistened with spirits of turpentine on the back, and washed with a varnish which renders it perfectly transparent. The colors are now applied, the same as with the varnish, to the back of the picture; a few shadings are applied to the face; and, when completed, it is covered with a coat of mastic varnish. This is an art readily accessible to all who have leisure and a small degree of skill; a very fair proficiency can be obtained after a very few lessons. It is a modern art, and within a short period has become widely practised.

There is another imitative art called Potichomania; will you explain what it is?

Potichomania is the art of decorating glass to resemble painted porcelain or Sèvres china. It is one of the modern fashionable arts, and appears to have sprung into general favor. The mode of operation is something like this: a plain glass vase is selected of the form and style desired. Colored engravings, Chinese figures, flowers, fruits, birds, etc., being the kind usually selected, are then procured. The figures of the engravings are carefully cut out, and applied by gum to the uneven surface of the vase, according to the design adopted. These are then worked with a gum; after which a tint is selected to the taste of the artist, mixed with silver white, and carefully and thoroughly applied to the whole interior surface of the vase. Over this tint another coat of varnish is applied, and the work is completed. When skilfully done, the designs or ornaments well selected, the tints of the proper delicacy of hue, the effect is pleasing, and not unlike the costly vases of real china or porcelain.

What is the Aquarium?

The aquarium (singular *aquarium*, plural *aquaria*,) is a modern combination of art and science which has created a furor for the study of a most entertaining branch of natural history. The aquarium is simply a comprehensive fish-globe, which, being furnished with living plants as well as living animals, the functions of each supply the necessities of the other; the fish drawing the life-sustaining oxygen from the plants, the plants flourishing upon the carbonic gas exuded by the fish. By this simple poise of operations the water of an aquarium need never be changed; and in your little globe or glass case you may have in miniature all the mysterious phenomena of nature accompanying life beneath the billows. Fish, mosses, aquatic plants, and marine animals in all their strange and beautiful variety, compose the aquarium; shells and sand form its bottom, and rocks, arranged with grottoes or other tasteful shapes, give picturesque beauty to the whole. The study of the aquarium is exceedingly fascinating; and in England, more than with us, they have become so popular that a parlor is scarcely considered furnished without its marine or fresh-water aquarium.

The aquarium is not only self-supporting, but self-renovating; and the part performed by the little water-snails and some other animals is not the least interesting part of the operations of these worlds in miniature. When the principle was first applied a difficulty occurred in the accumulation of decomposing vegetable matter arising from the death of plants in the ordinary course of nature. The fish would not eat the decaying plants, and hence they poisoned the water, and killed the animals. But it was discovered that the little water-snails consumed these dead and decomposing leaves in the bottoms of our ponds. The experiment was tried with them in the aquarium, and, to the delight of the experimenter, they removed every vestige of decomposing matter. They acted as scavengers, and completely restored the water to its clearness and purity.

What is the process of gilding frames and other substances?

The beauty and durability of gold render it the most valuable of all ornamental substances; but on account of its weight and price, its use in these respects would be exceedingly limited, were it not the most extensible and divisible, so that it may be made to cover a larger surface than an equal quantity of any other body.

Gilding, when performed by gold-leaf, and intended for out-door work, is laid on by the help of *gold size*, which is drying-oil mixed with calcined red ochre; or if for picture and looking-glass frames, they are prepared by a size made by boiling parchment clippings to a stiff jelly, and mixed with fine Paris-plaster or yellow ochre. Metals are gilded by an entirely different process known as *water-gilding*.

Will you describe it?

The surface of the metal is perfectly cleaned; it is then rubbed over with a solution of gold in mercury, called *amalgam of gold*; the vessel is next heated over a clear charcoal fire, by which the mercury is driven off, and the gold left adhering to the metallic surface upon which it is afterward burnished. Copper and brass are usually prepared by cleaning, and rubbing them over with a solution of nitrate of mercury. Brass and copper buttons are gilt in this way, and the requisite quantity of gold is so small that twelve dozen buttons of one inch diameter may be completely gilt upon both surfaces by five grains of gold.

How are the leaves of books gilt?

The books while in a press are brushed over with a composition of four parts of Arminian bole and one of powdered sugar-candy mixed up with white of egg; this coating when nearly dry, is smoothed by the burnisher, then slightly moistened, and the gold-leaf applied and burnished.

What are Artesian Wells?

Wells so named from having been long known and used in the province of Artois, in France. Their principle is the same as that of an artificial fountain. Thus, imagine a somewhat basin-shaped bed of sand, chalk, or any rock of a porous nature, to lie upon a stratum of clay impermeable to water, and to be covered by another stratum equally impermeable. The former bed, being saturated to a great extent by the water which flows into it from its higher and exposed edges—a hilly region, perhaps, where rain falls in abundance—becomes a reservoir, which, if an opening is bored down into it through the overlying clay, will discharge its waters upward, with a force determined by the level at which they are kept in the reservoir, the rate at which they can percolate through its substance, and the size of the orifice; and in proportion as this reservoir is tapped by the borer, must the supply it affords on its upper margin be diminished. The artesian bores are usually not more than a few inches in diameter.

What is the theory of the pump?

I have already told you that air, though comparatively light, is positively heavy, having a weight of its own. Its pressure is fifteen pounds on every square inch; and it is this weight of the atmosphere that pushes water into the void left by the up-drawn piston of a pump. But there is a limit beyond which it cannot push the water—namely, the point of height at which the column of water in the pump-tube is exactly balanced by the weight of the atmosphere. It is simply a question of balance; fifteen pounds can only support fifteen pounds; the limit of the height is about thirty-four feet, but it is not found practicable with pumps of the ordinary description to raise it more than twenty-eight feet.

What is the Blowpipe?

A tube through which air is blown into the flame of a candle or lamp, so that a portion of the flame is formed into a long slender cone in the direction of the jet, the heat of which increases toward the end of the cone, and at the point is most intense. A common flame thus becomes a small furnace; so that a small piece of any substance may be subjected to a high temperature almost instantly, and fused. It is used in soldering by the jewelers and workers in fine metals; also by the glass-blowers.

What is the Diving-bell?

The oldest information we have respecting the use of the diving-bell is that of John Taisnier, quoted by Schott. The former, who was born at Hainault in 1509, had a place at court under Charles V., whom he attended on his voyage to Africa. He relates in what manner he saw at Toledo, in the presence of the emperor and several thousand spectators, two Greeks let themselves down under water, in a large inverted kettle, with a burning light, and rise up again without being wet. It appears that this art was then new to the emperor and the Spaniards, and that the Greeks were induced to make the experiment in order to prove the possibility of it.

What is the principle of the diving-bell?

The principle of the diving-bell exists in the impenetrability of atmospheric air, and may be explained by a very familiar experiment. Bring the edge of an inverted tumbler, or any close vessel, to the surface of water, and keeping the mouth horizontal, press it down in the water. It will be seen that though some portion of the water ascends into the tumbler, the greater part of the space remains empty, or only filled with air; and any object placed in this space, though surrounded on all sides with water, would remain perfectly dry. In fact, the quantity of air remains the same, but it is compressed into a smaller volume, in proportion to the depth to which it is made to descend.

What is the Stereoscope?

The name stereoscope, from the Greek words *stereos*, *solid*, and *skopein*, to see, has been given to an instrument of recent invention, originally designed for the purpose of demonstrating the theory of binocular vision; or, in other words, of exhibiting the effects and advantages of having two eyes. The instrument is so constructed that two flat pictures, taken under certain conditions, shall appear to form a single solid or projecting body, possessing all the soundness, solidity, and reality of nature, and apparently as large as life.

A very remarkable result, certainly. Will you explain how it is obtained?

The phenomena cannot be explained without some knowledge of the science of optics, and I will state a few general principles in as plain a manner as the subject will admit:

All bodies are rendered visible by the light which radiates from every point of their surfaces, each ray of light carrying with it the image of the object from which it emanated. These rays are refracted by the crystalline lens and other humors of the eye; and are brought to a focus so as to form a picture of the object, upon a delicate expansion of the optic nerve, termed the retina, which picture is precisely similar to that formed by the lens in the ordinary camera obscura. The impressions thus produced are conveyed to the brain, or sensorium, by the optic nerves; so that the eye does not see, but is merely the instrument by means of which the mind perceives external objects, while the judgment, derived from experience, determines their shapes and distances.

A picture of an object is formed on the retina of each eye; but although there may be but one object presented to the two eyes, the pictures formed on the two retinæ are not precisely alike, because the object is not observed from the same point of view.

Will you give me an illustration of this?

If the right hand be held at right angles to, and at a few inches from the face, the back of the hand will be seen when viewed by the right eye only, and the palm of the hand, when viewed by the left eye only; hence the images formed on the retinæ of the two eyes must differ, the one including

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more of the right side, and the other more of the left side of the same solid or projecting object. Again, if we bend a card so as to represent a triangular roof, place it on the table with the gable-end toward the eyes, and look at it, first with one eye, and then with the other, quickly and alternately opening and closing one of the eyes, the card will appear to move from side to side, because it is seen by each eye under a different angle of vision. If we look at the card with the left eye only, the whole of the left side of the card will be plainly seen, while the right side will be thrown into shadow; and thus *two* images of the *same* object, with *differences of outline, light, and shade*, will be formed, the one on the retina of the right eye, and the other on the retina of the left. These images, falling on corresponding parts of the retinæ, convey to the mind the impression of a single object, while experience, having taught us, however unconscious the mind may be of the existence of two different images, that the effect observed is always produced by a body which really stands out or projects, the judgment naturally determines the object to be a projecting body.

It is experience also that teaches us to judge of distances by the different angles of vision under which an object is observed by the two eyes; for the inclination of the optic axes, when so adjusted that the images may fall on corresponding parts of the retinæ, and thus convey to the mind the impression of a single object, must be greater or less according to the distance of the object from the eyes.

Perfect vision cannot, then, be obtained without two eyes?

No, for it is by the combined effect of the image produced on the retina of each eye, and the different angles under which objects are observed, that a judgment is formed respecting their solidity and distances.

A man restored to sight by couching cannot tell the form of a body without touching it, until his judgment has been matured by experience, although a perfect image may be formed on the retina of each eye. A man with only one eye cannot readily distinguish the form of a body which he had never previously seen, but quickly and unwittingly moves his head from side to side, so that his one eye may alternately occupy the different positions of a right and a left eye; and, if we approach a candle with one eye shut, and then attempt to snuff it, we shall experience more difficulty than we might have expected, because the usual mode of determining the correct distance is wanting.

In order, then, to deceive the judgment, so that flat surfaces may represent solid or projecting figures, we must cause the different images of a body, as observed by the two eyes, to be depicted on the respective retinæ, and yet to appear to have emanated from one and the same object. Two pictures are therefore taken from the really projecting or solid body, the one as observed by the right eye only, and the other as seen by the left. These pictures are then placed in the box of the stereoscope, which is furnished with two eye-pieces, containing lenses so constructed that the rays proceeding from the respective pictures, to the corresponding eye-pieces, shall be refracted or bent outward, at such an angle as each set of rays would have formed had they proceeded from a single picture in the centre of the box to the respective eyes without the intervention of the lenses; and as it is an axiom in optics that the mind always refers the situation of an object to the direction from which the rays appear to have proceeded when they entered the eyes, both pictures will appear to have emanated from one central object; but as one picture represents the real or projecting object as seen by the right eye, and the other as observed by the left, though appearing by refraction to have proceeded from one and the same object, the effects conveyed to the mind, and the judgment formed thereon, will be precisely the same as if the images were both derived from *one solid or projecting body*, instead of from *two pictures*, because all the usual conditions are fulfilled; and, consequently, the two pictures will appear to be converted into one solid body.

Is the principle involved in the Stereoscope of recent discovery?

No; it has been known for two thousand years, but its application in this familiar instrument is of very recent date. Within a few years the stereoscope has become a rage; it finds its way into almost every social circle, and has become a familiar source of fashionable parlor amusement. The trade in them is universal; thousands of people are employed in the sale and manufacture of the instrument, and photographers are employed in every part of the globe in taking binocular (or double) pictures—among the ruins of Pompeii and Herculaneum—on the glaciers and in the valleys of Switzerland—among the public monuments and natural wonders in the Old and New World—and in the scenes of domestic life.

What is a Balloon?

A globe made of silk and rendered air-tight by gum, which, when filled with hydrogen gas—from ten to thirteen times lighter than atmospheric air—ascends into the atmosphere, and will carry heavy bodies suspended to it.

The principle upon which a balloon rises in the atmosphere is exactly the same as that which causes the ascent of a cork from the bottom of a vessel filled with water; the weight of the volume of air which it displaces must exceed the weight of the balloon and all that it carries with it. It was not till 1766 that hydrogen gas was found to be lighter than common air; and two brothers, Stephen and Joseph Montgolfier of Annonay, France, have the honor of being the first to prepare and send up a balloon into the air. This was in 1783.

Who were the first to undertake an aerial ascent in a balloon?

Pelatre de Rosier, a young naturalist, and the Marquis d'Arlandes. On the twenty-first of November 1783, they took their seats in the basket of a balloon, and after rising to an elevation of upward of three thousand feet, descended safely to the earth. This daring adventure became the talk of all France, and was soon followed by numerous other similar attempts.

What is the process of making bricks?

Bricks are made of clay mixed with sand, chalk, coal ashes and other substances, formed in a mould, and burned in a kiln or clamp. The ingredients being made into a paste by the introduction of a limited quantity of water, the mixture is raked backward and forward; it is put into what is called a *pug-mill*, which consists of an upright barrel, in which are placed a series of strong iron knives. The mill revolves by the power of a horse, walking in a circular path, and the paste is thoroughly cut and masticated by the knives, as it passes from the top of the barrel through an aperture provided for its exit at the bottom. As the clay oozes out it is removed with a concave shovel, and is ready for the moulder. Formerly the clay was moulded by hand; the mass was thrown into a wooden mould, shaped by a wooden instrument to the size of a mould, from which it was transferred to a pallet board, and was then ready for the kiln. But a machine, invented by J. Z. A. Wagner, of Philadelphia, is now employed for the moulding of bricks, which facilitates the operation greatly.

The kiln in which they are burnt is a large building, about thirteen feet long, ten feet wide, and twelve feet high, furnished with a proper furnace. They are sometimes burned in what is called a *clamp*, which is formed of the bricks themselves. The foundations are of old bricks. Each course of new bricks is laid on a layer of *breeze*, or cinders; and flues are formed, filled with coals, breeze, and wood. The burning lasts from twenty to thirty days.

Were the bricks of ancient times baked or burned as ours?

They were sometimes baked, but more commonly dried in the sun. Specimens of ancient brick found in the ruins of Babylon are among the oldest existing. The Egyptians used sun-dried bricks, and the process of making them is epr esented in their paintings, some of which are peculiarly of all France, and was soon followed by numerous other similar attempts.

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What is Gobelin Tapestry?

Gobelin Tapestry is so called from a noted house in Paris, in the suburb of St. Marcel, formerly possessed by famous wool-dyers, whereof the chief, called Giles Gobelin, who lived in the reign of Francis I., is said to have found the secret of dyeing scarlet, which was from him called the scarlet of the Gobelins; the house and the river that runs by it also took the same name. This house was purchased by Louis XIV., for a manufactory of all manner of curious works for adorning the royal palaces, under the direction of a Monsieur Colbert, especially tapestry, designs for which were drawn by the celebrated Le Brun, by appointment of the king, A. D. 1666.

What is Phonography?

Phonography includes every method of writing by signs that represent the sounds of the language. It differs from stenography in this respect: stenography uses characters to represent words by their spelling, instead of their sound; hence phonography is much the shortest and simplest mode of short-hand writing.

What is the Burning Glass?

A name given to a glass, or mirror, so formed as to collect the sun's rays which fall on it into a point, or small surface, and thereby produce an intense heat, and set fire to combustible substances. The point at which the rays meet, and where the greatest heat is produced, is called the *focus*, or *burning point*.

What is a Chronometer?

A timepiece of peculiar construction, at present much employed by navigators in determining the longitude at sea. Chronometers are, in general, much larger than common watches, and are hung in gimbals, in boxes six or eight inches square; but there are also many pocket chronometers, which, externally, have all the appearance of the better sort of pocket watches, and internally differ from those only in the construction of the balance. The balance and hair-spring are the principal agents in regulating the going of an ordinary watch, being to this what a pendulum is to a common clock; and this spring in the former, like the pendulum in the latter, is subject to expansions and contractions under different degrees of heat and cold, which affect the speed or rate of the machine; and the methods of correcting this inaccuracy mark the difference between the watch and the chronometer.

What is Stereotyping?

Stereotyping was invented in 1780, almost simultaneously by W. Ged, of Edinburgh, and Cadwallader Colden, of New York. It is one of the most important of the modern inventions in the art of printing, and consists of casts taken from ordinary type, which secures a plate of the page in a fixed and permanent form. The page, or form, which usually consists of three or four pages, is composed in ordinary types, from which a cast or mould is taken in plaster of Paris. The mould is immediately subjected to a heat of 300°, when it becomes perfectly dry in two hours. Of course the mould reverses the faces of the types; the reliefs of the metal types are indentations in the plaster. The types indeed have made an impression upon the surface of the plaster exactly as in the case of a printed page. It is now necessary to secure a cast the surface of which is the exact counterpart of the types, on which the surface of the plate, or cast, presents the appearance of types fixed instead of movable; it is also necessary to secure the cast in a firm and durable metal. The mould, therefore, is plunged into a bath of melted lead, or alloy, which pours into the plaster mould, and forms a cast or plate in which every delicate line of the types is preserved. From the bath the case is removed to a water-cistern, and when cooled is handed over to the picker, who planes its edges, carefully removes the little imperfections that gather upon its surface, etc. Each page of an entire book is cast and prepared in this way, and the peculiar advantage of the plan is, that not only may casts of the pages be multiplied to any extent, but the printer, from the same set of plates, may reprint editions of the work from year to year, or to any extent or number. Formerly, when an edition of a book was exhausted, the entire matter had to be reset.

What is Electrotyping?

Electrotypes preserve a sharper and more perfect line than stereotypes, and hence they are used for casts of wood-cuts, or other surfaces where great accuracy and delicacy of outline are desirable. The mould is placed in a galvanic battery, and the metal, which may be either gold, silver, or copper, but for ordinary purposes is copper, is precipitated from its solution, by the agency of electricity upon the moulds, in so fine a state of division as to form a coherent mass of pure metal, equal in toughness and flexibility to the hammered metals. This art is applied to reproducing fac-similes of medals, coins, etc.

What is Mosaic?

Mosaic is named from *opus musivum, musaicum, mosaicum*, perhaps because Mosaic pavements were principally employed in temples dedicated to the Muses. It is also called *opus tessellatum* and *vermiculatum*, because the cubes of which it is composed are disposed in curved lines.

A mosaic is a painting executed by means of small tubes, called *sectilia* and *tesseræ*, of marble, glass, or stones of various colors, set in a bed of cement or mastic, in figures of arabesques, scrolls, rosettes, or figures, and even entire historical and mythological compositions. The work is then other climbing plants, which serve to fix them against a wall, or the trunk of a tree, cannot be considered as roots; since, though they answer the purpose of sustaining the plant, they are unable to supply it with nourishment.

Is this the case with parasitical plants?

No. Their species, such as the misletoe, having no immediate communication with the earth, strike their fibres into the stems or branches of a tree, and derive their nourishment from this richly-prepared soil; yet, as the absorption in this case is not carried on by the regular mode of spongioles, their fibres are not denominated *roots*. The spongioles act only by capillary attraction and suck up moisture, just as a lump of sugar absorbs the water into which it is dipped. As a proof of this, it has been shown, that if roots, saturated with moisture, be transplanted into very dry earth, the latter will absorb the moisture from the roots. Absorption does not immediately cease upon the death of a plant, as the blood ceases to circulate upon the expiration of animal life; but when the vessels through which the fluid should pass have lost their vital energy, that susceptibility of irritation and contraction which enabled them to propel the fluid upward, ceases, and it can no longer ascend into the roots, but remains stagnant in the spongioles, which soon become saturated. Disease and putrefaction follow; and that nourishment which was designed to sustain life, now serves only to accelerate disorganization.

What are the different varieties of roots?

The botanists distinguish several kinds. The *radix fibrosa*, or fibrous root, is the most common in its form: it consists of a collection or bundle of fibres. The roots of many grasses, and most annual herbs, are of this description. The couch-grass is an example of the *radix repens*, or creeping-root. If an attempt be made to eradicate such roots, a succession of bunches of fibres are met with, springing from an apparent root which grows horizontally, and appears to be endless. This long horizontal fibre is, however, not a root, but a subterraneous branch, for it has no spongioles; the real roots are the small bundle of fibres which spring from it. Such a root is very tenacious of life, as any portion in which there is an articulation will grow. The ox-eye, whose strong penetrating roots strike deep into the earth, furnishes an example of the *radix fusiformis*, or spindle-shaped. It is also called the tap-root, from its tapering so considerably toward the end. The *radix bulbosa*, or bulbous root, such as that of the lily, the hyacinth, or the onion, is improperly so called, for the tufts of fibres, pendent from the bulb, are the roots.

What then is the bulb?

The bulb constitutes the stem of the plant. The potato belongs to the class of tuberous, or knotted roots, which are of various kinds, comprehending all such as have fleshy knobs, or tumors. In all cases they are to be considered as reservoirs of nourishment, which enable the plant to sustain the casual privations of a barren or dry soil. The root of the *orchis* is deserving of notice, from its singularity. It consists of two lobes, somewhat similar to the two parts into which a bean is divided. One of these perishes every year, and another shoots up on the opposite side of the remaining globe. The stem rises every spring from between the two lobes, and since the new lobe does not occupy the same place as its predecessor, the orchis every year moves a little onward.

What is the duration of roots?

They are either annual, biennial, or perennial. To the first belong plants the existence of which is limited to one season, such as barley, and a vast number of garden and field flowers. The biennial root produces, the first season, only herbage, and the following summer flowers and fruit, or seed; after which it perishes. To the perennial belong plants which live to an indefinite period, such as trees and shrubs.

Will you describe the office of stems in plants?

Every plant has a stem, through which the sap circulates, root, but a subterraneous branch, for it has no spongioles; the real roots are the small bundle of fibres which spring from it. Such a root is very tenacious of life, as any portion in which there is an articulation will grow. The ox-eye, whose strong penetrating roots strike deep into the earth, furnishes an example of the *radix fusiformis*, or spindle-shaped. It is also called the tap-root, from its tapering so considerably toward the end. The *radix bulbosa*, or bulbous root, such as that of the lily, the hyacinth, or the onion, is improperly so called, for the tufts of fibres, pendent from the bulb, are the roots.

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Every plant has a stem, through which the sap circulates, and from which the leaves and flowers spring. This stem is not always apparent; it is sometimes concealed underground, sometimes disguised under an extraordinary form. The stem of the tulip, for instance, is contained within the bulb, which is commonly, but improperly, called its root; that of the fern is subterraneous. The functions of the root and stem are totally different. The former merely sucks up nourishment from the soil, and transmits it to the leaves; the latter is supplied with organs to distribute it to the several parts of the plant, the leaves, the flowers, etc.

The stems of the plant are divided into two classes: those which grow internally, hence called *endogenous*—they are also called *monocotyledons*, from their seed having only one cotyledon, or lobe—and those which grow externally, called *exogenous*, or *dicotyledons*, from their seeds having two lobes.

There is a third class, denominated acotyledons, which have no lobes, and no vascular system, such as fungi, lichens, etc.

What plants belong to the first class?

The date, the palm, and the cocoa-nut tree, the sugar-cane, and most of the trees of tropical climates, belong to the monocotyledons, or endogenous plants. Their stems are cylindrical, being of the same thickness from the top to the bottom. Their mode of growth is this: a hollow stem shoots up to a certain height, and there stops; layer after layer grows in the interior of this hollow stem, till at length a period arrives when the outer coats are so hardened and distended, as to yield no longer; the stem has then attained its full growth in horizontal dimensions, and offers a broad, flat, circular surface to view, which has scarcely risen in height above the level of the ground. In this stage it resembles the stump of the trunk of a tree which has been cut down. The following spring, there being no room for a new layer of wood to extend itself horizontally, it shoots up from the centre of the stem vertically; fresh layers every year sucness. This mode of growing renders the form of the stem conical, the layers diminishing as the stem rises.

These layers of wood attain a state of maturity when they become so hard by continued pressure as to be no longer susceptible of yielding to it. Previous to this period, the layers bear the name of *alburnum*, signifying white wood, for wood is always white until it reaches this degree of consistency. The length of time requisite to convert the alburnum into perfect wood, varies from five to fifty years, according to the nature of the tree.

The vegetation of the bark is, then, the inverse of that of the wood?

Precisely; that is to say, it is *endogenous*, its layers growing internally; the new soft coat of bark, therefore, lies immediately in contact with the new soft layer of wood. The outer coats of bark, when they become too hard to be further distended by the pressure of the internal layers, crack, and becoming thus exposed to the injury of the weather, fall off in pieces: it is this which produces the ruggedness of the bark in some trees. The other layers, as they become external, and exposed to the same sources of injury, experience the same fate.

Through what part of the stem does the sap rise?

It has long been a disputed point; some have maintained the opinion that it ascended through the pith; others, that it rose through the bark; but they have both been proved to be wrong. By coloring the water with which the plant was watered, it has been traced within the stem, and found to ascend almost wholly in the alburnum, or young wood, and particularly in the latest layers.

What are the functions of leaves?

If the leaves of a tree be stripped off, the fruit comes to nothing, which is exemplified every year in gooseberry bushes, the leaves of which have been devoured by caterpillars; and though the fruit-trees of warm climates, partly naturalized with us, grapes and peaches, for instance, ripen their fruit sooner, perhaps, if partially deprived of their leaves, yet if that practice be carried too far, the fruit perishes. The white mulberry, indeed, cultivated in the south of Europe, for the food of silk-worms only, bears wonderfully the loss of its foliage three or four times a year.

These facts have led some to think that leaves were merely a clothing, or a protection against cold and heat. Though this is undoubtedly true, still it is a very small part of the use of leaves.

Do leaves give out moisture?

That leaves give out moisture, or are organs of insensible perspiration, is proved by the simple experiment of gathering the leafy branch of a tree, and immediately stopping the wound at its base with wax, or any other fit substance, to prevent the effusion of moisture in that direction. In a very short time, the leaves droop, wither, and are dried up. If the same branch, partly faded, though not dead, be placed in a very damp cellar, or immersed in water, the leaves revive, by which their power of absorption is also proved.

The great annual sunflower is said to have lost by perspiration one pound fourteen ounces weight, in the course of twelve hours, in a hot dry day. In a dry night it lost about three ounces; and in a moist night, scarcely any alteration was observable; but in a rainy night it gained two or three ounces. The cornelian cherry is most remarkable in this respect: the quantity of fluid which evaporates from its leaves in the course of twenty-four hours is said to be nearly equal to twice the weight of the whole shrub.

The perspiration of aquatic plants seems to be remarkably copious. Of these some grow constantly immersed in water. Their leaves are peculiarly vascular, and dry very quickly in the air, withering in a few minutes after exposure to it. Other aquatics float with only the upper surface of their leaves exposed to the air, which surface is so contrived that water will scarcely remain upon it. These leaves, though extremely juicy, dry with great rapidity, as does every part of the plant when gathered. It is probable that they imbibe copiously by their under sides, and perspire by their upper.

What effect has light upon plants?

A very powerful effect. The green color of the leaves is owing to it, so that plants raised in the dark are of a sickly white; and it is well known that the blanching of celery is effected by covering the plant and excluding the light.

Light acts beneficially upon the upper surface of leaves, and hurtfully upon the under side; hence the former is always turned toward the light, in whatever situation the plant may happen to be placed.

How is it with plants in a hot-house?

They present the fronts of their leaves to the side where there is most light, not to the quarter where most air is admitted, or to the flue, in search of heat. It has been found, that vine-leaves turn to the light, even when separated from the stem, if suspended by a thread.

Is this effect peculiar to leaves alone?

No; many flowers are equally sensible to it, especially the compound radiated ones, as the daisy, sunflower, marigold, etc. In their forms, Nature seems to have delighted to imitate the radiant luminary, in the absence of whose beams many of them do not expand their blossoms at all. The stately annual sunflower displays this phenomenon more conspicuously, on account of its size: the flower follows the sun all day, and returns, after sunset, to the east, to meet the sunbeams in the morning. A great number of leaves also follow the sun in his course. A clover-field is a familiar instance of this.

The chemical actions of light, heat, and the component parts of the atmospheric air, upon leaves, are now tolerably well understood.

Will you explain them?

It is agreed that in the daytime plants imbibe, from the atmosphere, carbonic-acid gas (which is a compound of oxygen and carbon), that they decompose it, absorb the carbon as matter of nourishment, which is added to the sap, and emit the oxygen. The burning of a candle, or the breathing of animals, in a confined space, produces so much of this gas, that neither of these operations can go on beyond a certain time; but the air so contaminated serves as food for vegetables, the leaves of which, assisted by light, soon restore the oxygen, or, in other words, purify the air again. This beautiful discovery shows a mutual dependence of the animal and vegetable kingdoms, and adds another to the many proofs we have of the wisdom and wonder-working power of the Creator of all things.

How do plants operate in the absence of light?

In the dark they give out carbonic acid, and absorb oxygen; but the proportion of the latter is small, compared with what they exhale by day, as must likewise be the proportion of carbonic acid given out; else the quantity of carbon added to their substance would be but trifling, especially in those climates in which the proportion of day to night is nearly equal, and which, notwithstanding, we know to be excessively luxuriant in vegetation.

There can be no question of the general purpose answered to the vegetable constitution by these functions of leaves. But when we attempt to consider how the peculiar secretions of different species and tribes of plants are formed; how the same soil, the same atmosphere, should, in a leaf of the vine, or sorrel, produce a wholesome acid, and in that of a spurge, or manchineel, a most virulent poison—how sweet and nutritious herbage should grow among the acrid crow-foot and aconite—we find ourselves totally unable to comprehend the existence of such wonderful powers in so small and, seemingly, simple an organ, as the leaf of a plant. The agency of the vital principle alone can account for these wonders, though it cannot, to our understanding, explain them. The thickest veil covers the whole of these processes; and so far have philosophers hitherto been from removing this veil, that they have not even been able to approach it. All these operations, indeed, are evidently chemical decompositions and combinations: but we neither know what these decompositions and combinations are, nor the instruments in which they take place, nor the agents by which they are regulated.

About Many Things.

What is the Boomerang?

A curved piece of wood, flat on one side, and slightly rounded on the other, which, if skilfully thrown, may be made to go in almost any direction the thrower pleases. It should be held horizontally in throwing it, and cast by bringing the arm backward, when, after making a variety of curves, the instrument will come back again to the person who sent it. This missile was used by the Australian aborigines, with which they were very dexterous in hitting birds. The principle of the boomerang has also been attempted to be applied to the propulsion of ships.

What is the substance used for violin strings, known as catgut?

The twisted muscular coat of the intestines of cattle and sheep. To separate the muscular from the peritoneal and mucous coats, the intestine is steeped, scoured, fermented, and inflated. It is then twisted, rubbed smooth with horsehair, bleached with sulphur, and dried. They are imported largely from Lyons and Italy.

What is Calking?

A process which consists of stuffing the crevices between boards with oakum, which is rope untwisted into its original state of fibre. The oakum is forced in by a blunt chisel and a mallet. When the crevices are calked, melted pitch is poured on them, or laid on with a pitch-mop. Calking affords great support, and serves to hold together more securely a vessel or any other movable wooden body.

What is the Gordian Knot?

A knot made by Gordius in one of the cords of his yóke, or, as some have it, in the leathers of his chariot harness, which was so very intricately twisted that it was impossible to discover where it began or ended. The oracle of Apollo having declared, that whosoever should untie the knot should be master of all Asia, many attemped it, but without success, till, at last, Alexander the Great, after attempting in vain to untie it, cut it asunder with his sword, and thus either eluded or fulfilled the prediction.

What is Acetic Acid?

The sour principle of vinegar. This acid occurs in the vegetable kingdom; it exists in the gastric juice and other animal secretions. The purest is that made by the oxidation of alcohol. It is caustic on the tongue and skin, is used as a scent, and when essential oils are added, constitutes the aromatic vinegar.

What is Lactic Acid?

Lactic Acid exists in buttermilk in abundance, and also in fresh milk. It does not crystallize, and is not applied to any useful purpose.

What is Oxalic Acid?

A vegetable acid, produced by the action of nitric acid upon sugar. This process yields it in slender, prismatic crystals, intensely sour, and soluble in about ten parts of cold water. It is a powerful poison, and, from its resemblance to epsom salts, has been sometimes mistaken for that harmless aperient. Chalk and water, if taken immediately, will prove an antidote.

What is Citric Acid?

An acid peculiar to the vegetable kingdom, and found in the juices of several kinds of fruit, especially those of the genus *Citrus*. It is chiefly prepared from the juice of lemons. It is used medicinally in febrile and inflammatory complaints, and when added to soda forms the ordinary effervescing draughts.

What is meant by Agrarian Laws?

Laws which forbid the possession of more than a certain extent of land by any single individual. The law of the Romans, called by way of eminence, *the Agrarian Law*, was proclaimed, in A. D. 268, by Spurius Cassius, enjoining an equal division of conquered lands, but limiting the number of acres each might possess.

Why are the terms Sock and Buskin applied to dramatic performers?

The Buskin was a high-heeled boot used by the Roman and Greek actors to give elevation to the stature. Buskin is used in contradistinction to the sock (*soccus*), the flat-soled shoe worn by comedians; hence both terms came to be used to express the tragic and comic drama.

What are Anodynes?

The word is from a Greek origin, and signifies "that which relieves pain." Anodynes are those substances which assuage pain, either by inducing sleep, as with laudanum, or by stupefying the senses, as with chloroform.

What are Aperient Medicines?

Those medicines which have a purgative quality, and facilitate evacuations by removing obstructions. They consist principally of castor-oil, calomel, epsom salts, senna, magnesia, rhubarb, etc.

What are Astringents?

Medicines that act directly reverse from aperients; they operate on the human system by drawing together, contracting, or binding the pores or tissues of the body. While other medicines are dissolved in the stomach, or carried by absorption to the blood and venous system, astringent medicines, as a general rule, act only mechanically; requiring no absorption to produce their effects, which are attained by mere contact of the medicine with the surface to which it is applied. Alcohol is an astringent; oak-bark, cherry-bark, logwood, gall-nuts, solutions of iron, zinc and lead, and muriatic and sulphuric acid, etc.

What is Asphyxia?

That condition of the body most nearly allied to death, in which the vital principle may be said to be in abeyance, but not extinct; where the heart and lungs have ceased to act, and the body, without pulsation or feeling, presents the appearance of an inert mass.

Atrophy is that condition of the system where, from diseased action of the whole or part, the entire body, or a portion or member of it, loses its nutrition, and becomes gradually thin and emaciated. The causes of atrophy, apart from the predisposing one of diseased action, are, the disuse of the body, or parts of it, through sedentary habits, paralysis, general or local, pressure from ligature or bandage, and an imperfect nutrition.

What is a Cabal?

Cabal denotes a number of persons united in some close design. It is used synonymously with *faction*, and is applied more particularly to combinations of political leaders. The term was first applied to the ministry of Charles II., from the initial letters of their respective names, viz.: Clifford, Ashley, Buckingham, Arlington, and Lauderdale.

What is a Carte-blanche?

A blank paper, signed at the bottom with a person's name, which the holder is entitled to fill up as he pleases. The word is applied generally to unlimited privileges.

What is a Cremona?

A general term applied to violins made at Cremona, in Italy, by the family Amati, during the seventeenth and eighteenth centuries, which have become celebrated throughout the world for their superiority over all others.

What is meant by Carat, as applied to Gold.

It is a weight used by goldsmiths and jewellers. Originally the Kaura bean was used for this purpose, hence the name. A carat is a weight of four grains, when used in weighing diamonds; and when used in reference to the fineness of gold, pure gold is supposed to weigh twenty-four carats of twelve grains each, and this pure gold is called fine. Thus, if gold be said to be twenty-two carats fine, it is meant that twenty-two twenty-fourths are pure gold, and two twenty-fourths alloy. 'Coin is usually twenty carats fine; while gold used for ornaments and jewelry varies from eighteen carats down as low as twelve and even ten carats. The alloy is usually silver. Gold in its pure state is too soft for ordinary use.

Will you explain the indications of the Barometer?

In very hot weather the fall of the mercury in the barometer denotes the approach of thunder-storms; otherwise, a sudden fall denotes high wind.

In *frosty* weather, the fall of the barometer denotes thaw.

If *wet* weather happens soon after the fall of the barometer, expect *little* of it.

In *wet* weather, if the barometer falls, expect much wet.

In *fair* weather, if the barometer falls much, and remains *low*, expect much wet in a few days, and probably wind.

N. B.—The barometer sinks lowest of all for wind and rain together; next to that, for wind—(except it be an east or north-west wind).

In *winter*, the rise of the barometer denotes *frost*.

In *frosty* weather, the rise of the barometer indicates *snow*.

If *fair* weather happens soon after the rise of the barometer, expect but little of it.

In *wet* weather, if the barometer rises high, and *remains* so, expect continued fine weather in a day or two.

In *wet* weather, if the mercury rises suddenly very high, fine weather will not last long.

There are certain fabrics termed Impermeable; will you explain what is meant?

The term is applied to fabrics rendered water-proof by one or other of the following substances:

1. Linseed-oil, to which a dyeing quality has been communicated by boiling with sugar of lead, etc.

2. The same, holding in solution a little caoutchouc.

3. A varnish made by dissolving caoutchouc in rectified naphtha, applied between two surfaces of cloth.

4. Vegetable or mineral pitch, applied hot with a brush, as in making tarpauling for covering goods in ships.

5. A solution of soap worked into cloth, and decomposed in it by the action of a solution of alum, whence results a mixture of acid fats and alumina, which insinuates itself among all the woolly filaments, fills their interstices, and prevents the passage of water.

6. A solution of glue, or isinglass, introduced into a stuff, and then acted upon by a solution of galls or tannin, when an insoluble leather is deposited in the stuff.

What is an Epigram?

In poetry, a short poem or composition in verse, treating of one thing only, and ending with some point, or lively, ingenious thought. The following compliment addressed by Pope to Lord Chesterfield, on being asked to write with that nobleman's pencil, may serve as well as any for a specimen:

> "Accept a miracle: instead of wit,
> See two dull lines by Stanhope's pencil writ."

There are numerous other poetical and literary terms which I may as well proceed to explain:

Epitaph. A monumental inscription in honor or memory of a person defunct; or an inscription engraven or cut on a tomb, to mark the time of a person's decease, his name, family, and usually some eulogy of his virtues or good qualities.

Emblem. A kind of painted enigma, which, representing some obvious history, with reflections underneath, instructs us in some moral truth, or other matter of knowledge; such as that very significant image of Scævola holding his hand in the fire, with the words *agere et pati fortia Romanum est*, (to do and to suffer courageously is Roman). An emblem is somewhat plainer than an enigma. Gale defines emblem, an ingenious picture, representing one thing to the eye, and another to the understanding. The emblems of Alciatus have been in as much reputation among the learned as those of Quarles among the vulgar.

ACROSTIC. In poetry, a kind of ingenious composition, disposed in such a manner that the initial letters of the verses form the name of some person, kingdom, place, motto, etc. The acrostic is considered by the critics as a species of false wit. Some pretend to find acrostics in the psalms, particularly in those called *abecedarian.*

ECLOGUE. In poetry, a kind of pastoral composition, wherein shepherds are introduced as conversing together. Theocritus and Virgil, among the ancients, have written eclogues. There were certain prose compositions termed eclogues, as those of Diodorus, Polybius, Ctesias, Theophrastus, Strabo, etc., in which sense the word signifies only extract or collection. M. Fontenelle observes, that the beauty of the eclogue is not attached to what is rural, but rather to what is calm and easy in the rural life.

ODE, among the ancients, signified no more than song, or a composition proper to be sung and composed for that purpose; and the singing was usually accompanied with some musical instrument, chiefly the lyre. The odes of the ancients, Vossius observes, had a regular return of the same kind of verse, and the same quantity of syllables in the same place of every similar verse; but in the modern ode, says he, there is nothing but confusion of quantities. The ancient odes are generally in honor of their gods;—the modern odes are generally in praise of heroes and great exploits. The distinguishing character of an ode is sweetness and sublimity.

EPODE. The third or last part of an ode, the ancient ode being divided into strophe, antistrophe, and epode. The epode was sung by the priest, standing still before the altar, after all the turns and returns of the strophe and antistrophe. The word epode then properly signified the end of the song.

STANZAS were first introduced from the Italian into the French poetry about the year 1580, and thence transferred into the English. Most of the Italian poems are divided into stanzas. A stanza is a number of grave verses, containing some perfect sense, terminating in a pause. There are stanzas of four, six, eight, ten, or twelve verses. The word is Italian, and signifies a stand, or station.

PROLOGUE. In dramatic poetry, a discourse addressed to the audience before the drama or the play begins. The original intention of the prologue was to advertise the audience of the subject of the piece, and to prepare them to enter more easily into the action, and sometimes to make an apology for the poet. This last article seems to have almost excluded the two former in the English drama, and to be in sole possession of the prologue. The prologue is of a more ancient standing than the epilogue. Among the ancients, the prologue was a part of the piece, not indeed an essential, but an accessory part; with us it is no part at all. With them the drama was opened with the appearance of the prologue, but with us it is not opened till after the prologue is delivered.

EPILOGUE. The last part of a discourse, or treatise, containing ordinarily a recapitulation of the principal matters delivered. Epilogue, in the drama, is a poetical composition addressed to the audience, when the play is over, by one of the principal persons or actors therein; containing usually some reflections on certain incidents in the play, particularly those of the part of the person who speaks it.

EPITOME. An abridgment, or a reduction of the principal matters of a large book into a little compass.

MADRIGAL is a little poetic piece, generally amatory, not confined either to the scrupulous regularity of a sonnet, or the subtilty of an epigram, but consisting of some tender, delicate, yet simple thoughts, suitably expressed. An epigram is noted for its pointed wit; but *this* rather for its tenderness and beautiful simplicity. The Italian and French songs and airs are often of the madrigal kind.

PINDARIC. In poetry, an ode formed in imitation of the manner of Pindar. Pindar, whence the manner takes its name, was of Thebes; he flourished about four hundred and seventy-eight years before Christ, and was contemporary with Æschylus. What we have remaining of his is a book of odes, all in praise of the victors in the Olympian, Pythian, Nemæan, and Isthmian games; whence the first is entitled the Olympians, the second the Pythians, the third Nemæans, and the fourth Isthmians. Pindar is full of force and fire; his thoughts sententious; his style impetuous; his sallies daring, and frequently running as it were at random; he affects a beautiful disorder, which is said to be the effect of the greatest art. The supposed irregularity of his numbers has made several of his imitators imagine themselves Pindaric poets by the mere wildness and irregularity of their verses. None of our writers seem to have succeeded in the Pindaric character better than Cowley; though some may prefer reading

> "Our modern Pindar, who, with artful story,
> Took wicked pains to tarnish kingly glory."

APOPHTHEGM is a short, sententious, and instructive remark, pronounced by a person of distinguished character.

APHORISM is a maxim, or precept, or the principle of a science, or a sentence which comprehends a great deal in a few words. The term is chiefly used in medicine and law. We say the aphorisms of Hippocrates, Boerhaave, etc.; aphorisms of the civil law; etc.

EPIC POEM. An heroic poem, or a poem reciting some great and signal transaction of a hero; called also epopœia, or epopee. Such are the Iliad and Odyssey of Homer, the Æneid of Virgil, the Gierusalemme of Tasso, and the Paradise Lost of Milton, which are the principal poems of the epic kind.

BELLES LETTRES, (or *Polite Literature*, as it is properly denominated in English,) embraces grammar, logic, rhetoric, poetry, music, mathematics, and the learned languages; these are usually called the seven Liberal arts. *Belles Lettres* and *Criticism*, says Dr. Blair, chiefly consider man as being endowed with those powers of taste and imagination which were intended to embellish his mind, and supply him with rational and useful entertainment. They open a field of investigation peculiar to themselves. All that relates to beauty, harmony, grandeur, and elegance—all that can soothe the mind, gratify the fancy, or move the affections, belong to their province.

What is the Zodiac?

A space round the heavens among the fixed stars, 15 degrees wide, the centre of which is the plane of the ecliptic, and it corresponds in breadth with the inclination of the sun's axis of 70° 30′, which thereby produces a maximum of force in that plane of the medium of space, but expanding as it diffuses around. The distant stars within it are divided into twelve portions, called signs: six to the north of the earth's equator, and six to the south; altogether fanciful, but referring to the business of the season when first applied, though to those superstition has annexed whimsical influences. The names of these signs, their hieroglyphics, and the days on which the sun enters them, are as follows: NORTHERN SIGNS—♈ *Aries*, the Ram, 21st of March. ♉ *Taurus*, the Bull, 19th of April. ♊ *Gemini*, the Twins, the 20th of May. ♋ *Cancer*, the Crab, 21st of June. ♌ *Leo*, the Lion, the 22d of July. ♍ *Virgo*, the Virgin, 22d of August. SOUTHERN SIGNS—♎ *Libra*, the Balance, 23d of September. ♏ *Scorpio*, the Scorpion, 23d of October. ♐ *Sagittarius*, the Archer, 22d of November. ♑ *Capricornus*, the Goat, 21st of December. ♒ *Aquarius*, the Water-bearer, 20th of January. ♓ *Pisces*, the Fishes, 19th of February. As we reckon the year by the earth's motions, and the solar year is 50.25″ of a degree shorter than the sidereal, so the time when the sun is on our equator is earlier every year by 20′ 23″ of time; hence the equinoctial points recede among the stars; but, as we always call the ascending point Aries, so the original stars go forward, and the equinoctial, with reference to them, recedes 50′ 25″ in a year; 1° 23′ 45″ in a century; a sign in 2,150 years, and the whole circle, in 25,791 years. It is, however, a mere change in relative appearances, and produces no mundane affection whatever.

What is the nature and cause of Winds?

A change in the temperature of a portion of air; an increase or a diminution of the quantity of water which it holds in a state of vapor; in short, any circumstance which causes it either to contract or expand destroys the equilibrium among the different parts of the atmosphere, and occasions a rush of air, that is, a wind, toward the spot where the balance has been destroyed.

Winds may be divided into three classes: those which blow constantly in the same direction; those which are periodical, and those which are variable. The permanent winds are those which blow constantly between, and a few degrees beyond, the tropics, and are called *trade-winds.* On the north of the equator, their direction is from the north-east, varying at times a point or two of the compass each way: on the south of the equator, they proceed from the south-east. The origin of them is this: the powerful heat of the torrid zone rarefies, or makes lighter, the air of that region; the air, in consequence of this rarefaction, rises, and to supply its place, a colder atmosphere from each of the temperate zones moves toward the equator. But these north and south winds pass from regions where the rotatory motion of the earth's surface is less to those where it is greater. Unable at once to acquire this new velocity, they are left behind, and, instead of being north and south winds, as they would be if the earth's surface did not turn round, they become north-east and south-east winds.

What are Monsoons?

The monsoons belong to the class of periodical winds. They blow half the year from one quarter, and the other half from the opposite direction. When they shift, variable winds and violent storms prevail for a time, which render it dangerous to put to sea. The monsoons, of course, suffer partial changes in particular places, owing to the form and position of the lands, and to other circumstances; but it will be sufficient to give their general directions. From April to October, a south-east wind prevails north of the equator—southward of this, a south-east wind. From October to April, a north-east wind north of the equator, and a north-west between the equator and 10° of south latitude.

What occasions Land and Sea Breezes?

The *land* and *sea breezes*, which are common on the coasts and islands situated between the tropics, are another kind of periodical winds. During the day, the air over the land is strongly heated by the sun, and a cool breeze sets in from the sea; but in the night the atmosphere over the land gets cooled, while the sea, and consequently the air over it, retains a temperature nearly even at all times; accordingly, after sunset, a land-breeze blows off the shore. The sea-breeze generally sets in about ten in the forenoon, and lasts till six in the evening; at seven the land-breeze begins, and continues till eight in the morning, when it dies away. These alternate breezes are, perhaps, felt more powerfully on the coast of Malabar than anywhere; their effect there extends to a distance of twenty leagues from the land.

Thus, within the limits of from twenty-eight to thirty degrees on each side of the equator, the movements of the atmosphere are carried on with great regularity; but beyond these limits the winds are extremely variable and uncertain, and the observations made have not yet led to any satisfactory theory by which to explain them. It appears, however, that beyond the region of the trade-winds, the most frequent movements of the atmosphere are from the south-west, in the north temperate zone. This remark must be limited to winds blowing over the ocean, and in maritime countries; because those in the interior of continents are influenced by a variety of circumstances, among which the height and position of chains of mountains are not the least important. Those south-west and north-west winds of the temperate zones are most likely occasioned in the following manner:—in the torrid zone there is a continual ascent of air, which, after rising, must spread itself to the north and south in an opposite direction to the trade-winds below: these upper currents, becoming cooled above, at last descend and mix themselves with the lower air; part of them may perhaps fall again into the trade-winds, and the remainder, pursuing its course toward the poles, may occasion the north-west and south-west winds of which we have been speaking. This interchange between the heated air of the tropics, and the cold air of the polar regions, greatly tends to moderate the climate of earth. Besides, the air from the tropics being richer in oxygen, on account of the more luxuriant vegetation decomposing a large quantity of carbonic acid, is well calculated to supply any deficiency in the amount of this most important substance, which might occur from the barrenness of a less favored climate.

What is the cause of Hurricanes?

They are supposed to be of electric origin. A large vacuum is suddenly created in the atmosphere, into which the surrounding air rushes with immense rapidity, sometimes from opposite points of the compass, preading the most frightful devastation along its track, rooting up trees, and levelling houses with the ground. They are seldom experienced beyond the tropics, or nearer the equator than the ninth or tenth parallels of latitude; and they rage with the greatest fury near the tropics, in the vicinity of land or islands, while far out in the open ocean they rarely occur. They are most common among the West India Islands, near the east coast of Madagascar, in the islands of Mauritius and Bourbon, in the Bay of Bengal, at the changing of the monsoons, and on the coasts of China.

What are Whirlwinds?

Whirlwinds sometimes arise from winds blowing among lofty and precipitous mountains, the form of which influences their direction, and occasions gusts to descend with a spiral or whirling motion. They are frequently, however, caused by two winds meeting each other at an angle, and then turning upon a centre. When two winds thus encounter one another, any cloud which happens to be between them is of course condensed, and turned rapidly round: and all substances sufficiently light are carried up into the air by the whirling motion which ensues. The action of a whirlwind at sea occasions the curious phenomenon called a *water-spout.*

What are Waves?

The oscillations produced on fluid or other yielding bodies by the action of wind. The sands of the desert are frequently formed into waves by the action of this sort of disturbing force, and the waves formed on water by the same force are superficial oscillations of the fluid.

Are these oscillations irregular?

They are much more regular than might be inferred. The pendulum, it is well known, when drawn out of a perpendicular line, endeavors to regain it; but in doing this, it has obtained a velocity which carries it out of the perpendicular on the opposite side; the same principle of motion distinguishes waves. The first impression of the wind upon the water is to produce a cavity; this cavity cannot be produced without heaping up the water before it. The water thus heaped having attained an elevation proportionate to the force which caused the depression, sinks down toward its level; but, in thus sinking down, it acquires a velocity which carries it below its level. By this means it produces a depression like that occasioned by the wind in the first instance, and thus successive waves are propagated, but the motion diminishes in proportion to the distance over which the force extends.

To what depth is the sea agitated by waves?

At twenty feet below what is a level in a calm the effect is very slight; and at thirty feet it would probably be altogether imperceptible.

How then do you account for the mountainous waves encountered by seamen?

It must be remembered that the wind is constantly acting, and that one wave is raised on another, till the accumulation becomes prodigious.

It has been discovered, that the power of wind on a surface of oil is exceedingly small, and that a quantity of oil, say in the proportion of half a gallon to an acre, poured out on the windward side of a lake, will spread itself over the whole surface, and still the waves raised by a tempestuous wind. Captains of vessels, therefore, sometimes use oil to diminish a surf; and pearl-divers do the same, when they wish to clear the surface of the sea before they go down.

Is not the power of waves very great?

The dynamic force exerted by waves is greatest at the crest of the wave before it breaks, and its power in raising itself is measured by various facts. At Wasberg, in Norway, in 1820, it rose four hundred feet, and on the coast of Cornwall, in 1848, three hundred feet. There are, likewise, cases, showing that waves have sometimes raised a column of water equivalent to a pressure of from three to five tons to the square foot. It has also been proved that the velocity of waves depends on their length; that waves of from three hundred to five hundred feet in length, from crest to crest, travel with a velocity of from twenty to twenty-seven and a half miles an hour; and this whether they are five or fifty-four feet in total height. Waves travel very great distances, and are often raised by far-off hurricanes, having been felt simultaneously at St. Helena and Ascension, though six hundred miles apart; and it is probable that ground-swells often originate at the Cape of Good Hope, three thousand miles distant.

At the meeting of the British Association in 1850, Mr.

Stevenson stated, as the result of experiments made by an accurate self-registering instrument, that the force of the waves may be stated to be a force of one and a half tons per square foot for the German Ocean, and of three tons for the Atlantic Ocean. The experiments were made at Bell Rock and Skerryvore light-houses.

What is the cause of Tides?

The tides are produced by the attraction of the moon. The cohesion of fluids being much less than that of solid bodies, they more easily yield to the power of gravity, in consequence of which, the waters immediately below the moon are drawn up in a protuberance, producing a full tide, or what is commonly called high-water, at the spot where it happens. According to this theory, you would imagine we should have full tide only once in twenty-four hours—that is, every time that we were below the moon—while we find that we have two tides in the course of twenty-four hours, and that it is high-water with us and with our antipodes at the same time.

Will you explain how this occurs?

This opposite tide is rather more difficult to explain than that which is drawn up beneath the moon. In order to render the explanation more simple, let us suppose the earth to be everywhere covered by the ocean. Now, the waters on the surface of the earth directly beneath the sway of the moon (which we will suppose to be at the equator), will be drawn by attraction away from the poles, into the elevation, or protuberance, spoken of; but, at the same time, the waters directly at the antipodean, or opposite, line of the moon will also exhibit an elevation similar to that produced by the moon in her direct influence. The water indeed will appear flattened at the poles, and will swell into elevations on each side, at the centre or girdle of the globe. The opposite, or antipodean, elevation will be caused by the earth itself being drawn away from the waters; that is to say, the first tide is produced by the waters receding from the earth, and the second, or opposite tide, by the earth receding from the waters.

Does not the Sun have some influence on the tides?

The influence of the sun on the tides is less than that of the moon; for observe that the tides rise in consequence of the moon attracting one part of the waters more forcibly than another part; it is this inequality of attraction which produces full and ebb tides. Now, the distance of the sun is so great, that the whole globe of the earth is comparatively but as a point, and the difference of its attraction for that part of the waters most under its influence, and that part least subject to it, is but trifling; and no part of the waters will be much elevated above or much depressed below their general surafce by its action. The sun has, however, a considerable effect on the tides, and increases or diminishes them as it acts in conjunction with, or in opposition to, the moon.

The moon is a month in going round the earth; twice during that time, therefore, at full and at change, she is in the same direction as the sun. Both, then, act conjointly on the earth, and produce very great tides called spring tides; but when the moon is at the intermediate parts of her orbit, the sun, instead of affording assistance, weakens her power by acting in opposition to it; and smaller tides are produced, called neap-tides.

What is the cause of the variations in the time of the tides?

The earth revolves on its axis in about twenty-four hours; if the moon were stationary, therefore, the same part of our globe would, every twenty-four hours, return beneath the moon; but as, during our daily revolution, the moon advances in her orbit, the earth must make more than a complete rotation in order to bring the same meridian opposite the moon; we are about three-quarters of an hour in overtaking her. The tides, therefore, are retarded, for the same reason that the moon rises later, by three-quarters of an hour every day. This, however, is only the average amount of the retardation. The time of the highest tide is modified by the sun's attraction, and is between those of the tides which would be produced by the separate action of the two luminaries. The action of the sun, therefore, makes the interval different on different days, but leaves the average amount unaffected.

Will you explain the revolutions of the moon, and the causes of Eclipses?

The moon revolves round the earth in the space of twenty-seven days eight hours, in an orbit nearly coinciding with the plane of the earth's orbit, and accompanies us in our revolution round the sun. Her motion, therefore, is of a complicated nature; for, as the earth advances in her orbit, whilst the moon goes round her, the moon proceeds in a sort of progressive circle.

The moon always presents the same face to us, by which it is evident that she turns but once upon her axis while she performs a revolution round the earth; so that the inhabitants of the moon have but one day and one night in the course of a lunar month. Since we always see the same hemisphere of the moon, the inhabitants of that hemisphere alone can see the earth. One half of the moon, therefore, enjoys our light every night, while the other half has constantly nights of darkness; and we appear to the inhabitants of the moon under all the changes, or phases, which the moon exhibits to us.

When the moon is in the same direction from us as the sun, we cannot see her, as her dark side is toward us; but her disappearance is of very short duration, and, as she advances in her orbit, we perceive her under the form of a new moon. When she has gone through one-sixth of her orbit, one quarter of her enlightened hemisphere will be turned toward the earth, and she will then appear horned. When she has performed one quarter of her orbit, she shows us one half of her enlightened side. She next appears gibbous; and after that full. As she proceeds in her orbit, she becomes again gibbous and her enlightened hemisphere turns gradually away from us, till she completes her orbit and disappears; and then again resumes her form of a new moon.

When the moon is full, she is always in opposition to the sun—when a new moon, in conjunction with it. At each of these times the sun, the moon, and the earth are in the same right line; but in the first case, the earth is between the sun and the moon; in the second, the moon is between the sun and the earth. An eclipse can only take place when the sun, moon, and earth are in a straight line, or nearly so. When the moon passes between the sun and the earth, she intercepts his rays, or, in other words, casts a shadow on the earth: this is an eclipse of the sun, and it continues whilst the shadow is passing over us. When, on the contrary, the earth is between the sun and the moon, it is we who intercept the sun's rays, and cast a shadow on the moon; she then disappears from our view, and is eclipsed.

Why have we not a solar and a lunar eclipse every month?

Because the planes of the orbits of the earth and moon do not exactly coincide, but cross or intersect each other; and the moon generally passes either on one side or the other, when she is in conjunction with, or in opposition to, the sun; and, therefore, does not intercept the sun's rays, or produce an eclipse; for this can only take place when the earth and moon are in conjunction near those parts of their orbits which cross each other (called the nodes of their orbits), because it is then only that they are both in the same plane, and in a right line with the sun. A partial eclipse takes place when the moon, in passing by the earth, does not entirely escape her shadow. When the eclipse happens precisely at the nodes, they are not only total, but last for some length of time.

When the sun is eclipsed, the total darkness is confined to one particular spot of the earth, as the moon's shadow is not large enough to cover the earth. The lunar eclipses, on the contrary, are visible from every part of the earth where the moon is above the horizon.

What is Horse-Power?

A unit of force introduced by Watt to enable him to determine what size of engine to send to his customers to supersede the number of horses which the new power was to replace. Watt ascertained that the average force exerted by the strongest horse in one of the London breweries was sufficient to raise thirty-three thousand pounds one foot high in a minute; thus, an engine of two hundred horse-power would be a force equal to that of two hundred horses, each lifting thirty-three thousand pounds one foot high per minute. In modern practice, however, owing to various modifications and allowances made for friction and other things, the term horse-power has ceased to have so definite a meaning. It is made now to refer rather to the size of the cylinder than to the power exerted, and the value of the unit has been so varied that a horse-power may imply fifty-two thousand pounds, or sixty thousand pounds, or sixty-six thousand pounds, raised one foot high per minute.

What are the laws of Motion?

All the phenomena of motion are derived by deductions from the three following laws of motion of Newton:

1. A body must continue forever in a state of rest, or of uniform motion in a straight line, if it be not disturbed by the action of an external cause.

2. Every change of motion produced by any external force is proportional to the force impressed, and in the direction of the straight line in which the force acts.

3. Action and reaction are equal and in contrary directions; that is, equal and contrary changes of motion are produced on bodies which mutually act on each other.

What is Centrifugal Force?

The force by which a body in rotation tends to recede from the centre of motion. *Centripetal force* is that by which a body in motion is urged toward a centre, and compelled to describe a circle instead of a straight line.

The stone to which a boy gives accumulated force by wheeling it around in a sling is, for a time, kept in its circle by the central or centripetal force, represented by the string; when let loose it darts forward in the air, impelled by the centrifugal force.

The heavenly bodies were impelled in the beginning by the Creator, with an almighty power, and would be obliged by their *inertia* (that is, the entire indifference of matter to motion or rest) to go on eternally in one direction, and with the same velocity, if they were not attracted in all points of their motion, toward a point out of this direction, by which a circular motion is produced.

In consequence of the centrifugal force occasioned by the rotation of the earth, the weight of bodies at the equator is diminished the 289th part. If the earth revolved on its axis in eighty-four minutes, the loose parts, and all movable matter, near the equator, would be projected from the surface.

Does not all matter have a tendency to rest?

No; this has long been a common error. There is abundant proof of the permanence of motion; and if friction and the resistance of air, the two most universal obstacles to the motions of bodies near the surface of the earth, could be entirely removed, instances of permanent motion would be still more numerous. The heavenly bodies, as I have said, moving in free space, subject to no opposing influence, keep on in their path with a velocity which has remained unabated since first they were launched from the hand of the Creator.

Numerous experiments upon the laws of motion have been made. A pendulum in a vacuum, having only the stiffness of the ribbon by which it is suspended to overcome, will vibrate for a whole day. A spinning top in the same situation, retarded only by the friction of its point, is said to continue spinning for hours. Indeed the conclusion cannot be avoided, that a body once put in motion would, if left to itself, continue to move with undiminished velocity. In all experiments the continuance of the motion is proportional to the diminution of friction and resistance.

Another consequence or particular of the law of motion is, that motion is communicated gradually. A force which communicates a certain quantity of motion in one second, will impart double the quantity in two seconds.

A ship does not yield at once to the impulse of the wind, when the sails are set; its motion increases as new portions are successively unfurled. A horse does not start at once with a carriage into the utmost speed; his force is at first spent in giving motion to the inert mass. The motion communicated to a body, if not destroyed by some force, is accumulated. A force of fifty pounds, communicated every second to a loaded wheel, will, if not diminished by friction or other cause of waste, enable it to overcome a resistance of five hundred pounds once in every ten seconds. Such a wheel is called a *fly-wheel.*

If two or more forces act at once on a body in different directions, it will take a direction different from either force. A boat rowed at the rate of three miles an hour directly from the bank of a river which runs at the rate of two miles an hour, is acted on at once by the force of the rowers and the current, and will be found, at the end of an hour, three miles from the bank, and two miles below the point from which it started, having moved in a diagonal line between the directions of the two forces. This is an illustration of the second law of motion.

Will you give some illustrations of the third law of motion?

If you press a stone with your finger, the finger is equally pressed by the stone. A horse drawing upon a load is drawn backward by its whole weight, and if he succeed in moving it, it can only be with a velocity proportioned to the excess of his strength over the reaction of the load. Two equal parts drawn toward each other by a rope, if both are free, meet in the middle. A gun when discharged recoils with a force equal to that with which the ball is propelled, but with a velocity so much less as its weight is greater. A consequence of this law is, that the earth is attracted by each body on its surface as much as it attracts, and that when a stone falls toward the earth, the earth rises to meet it.

What are the simple Mechanical Powers?

The *lever*, the *pulley*, the *wheel* and *axle*, the *inclined plane*, the *wedge*, and the *screw*—six in number. All machines are formed by a combination to a greater or less extent of these six elements.

What is the Lever?

A bar, resting on a support, called a fulcrum or prop, for the purpose of raising, by a power applied to one end, a weight at the other. The fulcrum must be nearer to the weight than to the power. If the distance from the power to the fulcrum be five times greater than that between the fulcrum and the weight, a force of one pound in the power will balance a pressure of five pounds' weight.

What is the Pulley?

A wheel movable about an axis, and having a groove cut in its circumference over which a cord passes. They are of two kinds, fixed and movable. The fixed afford no economy of power, but enables us to apply it more conveniently by changing its direction. The movable pulley changes its position with that of the weight and effects a saving equal to half the power.

What are the Wheel and Axle?

The wheel and axle consist of a wheel attached to a small cylinder, and moving on the same axis. The weight to be raised has a cord winding around the cylinder, and the power is attached to the circumference of the wheel. It may be regarded as a continual lever, each spoke of the wheel representing the long arm, and the radius of the cylinder the short arm. The *capstan* is a vertical wheel and axle, used on board ships to weigh the anchor.

What is the Inclined Plane?

A mechanical power which acts by sustaining a portion of the weight to be raised, while the direction of the applied force is changed from the perpendicular to one more or less horizontal, and the weight moves upward on it in a diagonal between them. As the length of the plane is to its height, so is the weight to the power.

What is the Wedge?

The wedge may be regarded as two inclined planes, united by a common base, acting on two weights, or resistances, at once, or on a fulcrum and a weight, between which it moves generally, in practice, by the impulse of successive blows.

What is the Screw?

The screw is an inclined plane, and may be supposed to be generated by an inclined plane wound spirally round a cylinder. The advantage gained by it depends on the slowness of the ascent, that is, on the number of turns, or threads, as they are called, in a given distance. It is generally used in combination with the lever. It is a machine of great power, commonly employed to produce compression, or to raise heavy weights.

What is Reflection?

The throwing back of light from any light-colored or polished surface. When a ray of light falls upon any body, it is reflected so that the angle of incidence is equal to the angle of reflection. It is supposed, that in the reflection of light it does not actually come into contact with the surface of the body that reflects it, but that this effect is occasioned by some power that acts at a small distance from the surfaces of reflecting bodies.

What is Refraction?

The turning or bending of light out of its natural course. When a ray of light enters any transparent medium in a direction oblique to its surface, it will not continue in the same direction, but will be drawn toward a straight line, perpendicular to the same surface.

What is the cause of dew?

Dew does not *fall*, as it is commonly expressed; it collects. The vapors raised by the heat of the sun during the day condense by the cold of the night, and settle on different bodies. As evidence that dew does not fall, is the fact that objects frequently exhibit deposits of dew on the under as well as the upper surface.

What is Mildew?

This term is generally applied to a particular mouldy appearance on the leaves of plants, which is produced by innumerable minute fungi, which, if not checked in their growth, will occasion the decay and death of the parts on which they grow. In agriculture, this appearance is frequently termed rust, and sometimes blight. The causes favorable to the production of mildew are a rich soil and a moist atmosphere. Powdered sulphur applied to the leaf will remove the disease.

What is Mouth-glue?

Mouth-glue is made by dissolving, by the aid of heat, pure glue, as parchment-glue, or gelatine, with about one-quarter or one-third of its weight of coarse brown sugar, in as small a quantity of boiling water as possible; this, when perfectly liquid, should be cast into thin cakes, on a flat surface very slightly oiled, and, as it cools, cut up into pieces of a convenient size. When required for use, one end may be moistened by the mouth, and is then ready to be rubbed on any substances it may be wished to join; a piece kept in the desk or work-box is exceedingly convenient.

From what does January derive its name? Will you give me the origin of the names of all the months?

January was named by the Romans after *Janus*, a double-faced deity, who was presumed to look both into the old year and the new, and in this month a great festival was held in his honor. Our custom of new year's gifts was derived from the Roman festivals of this month.

February, the second month in the year, is derived from *februo*, to purify or cleanse. February was not in the calendar of Romulus. It was added to the year by Numa, who gave it the twelfth place in the calendar. The Decemviri transferred it to the place in which it now stands.

March was named by Romulus in honor of his supposed father, Mars, the god of war. Until January and February were added to the calendar, the Romans made it the first month of the year. It was called by the Saxons *Lenet-monat*, or length-month, because in this month the length of the day begins to exceed that of the night. It has been said that *Lenet* signifies spring, and that therefore it was called spring month. As our Saxon ancestors observed the custom of fasting after they embraced Christianity, and as the period of this observance usually fell in the *Lenet-monat*, it was called the *Lenet* fast, hence, by corruption, our modern word of *Lent.*

April is derived from the Latin word *aperio*, to open, and was no doubt bestowed in allusion to the season; for the earth opens her bosom and sends forth her riches, and the young buds open under the influence of April showers.

May; there is some doubt about the origin of the name of this month; because, although the Romans offered sacrifices to MAIA, the mother of Mercury, upon the first day of this month, yet it appears pretty evident that the name was fixed long before the time of Romulus.

June; divers opinions exist as to the origin of the name of this month. Some derive it from Junius Brutus, who expelled the Tarquins from Rome on the first of this month, and settled the government upon the people; others assert that it is derived from the Latin word *junius*, because it is considered as the month for young persons. The most probable and more generally received opinion is, that it derives its name from the goddess Juno, in honor of whom a festival was celebrated at the commencement of the month.

July was originally called *Quintilis*, being the fifth month of the old Latin year. In consequence of the alterations made in the calendar it became, as now, the seventh month of the year, but still retained its name of Quintitis until Marc Antony changed it to *Julius*, in compliment to Julius Cæsar.

August derived its name from Augustus Cæsar, to whom it was dedicated in honor of his being created consul in this month.

September being originally the seventh month in the calendar, derived its name from *septem*, seven, and *imber*, a shower of rain. Notwithstanding its numerical change in the order of the months, its ancient appellation still adheres, although manifestly improper. The Senate of Rome once proposed to call it Tiberius, in honor of that emperor, but he declined the compliment.

October, the eighth month of the old Roman calendar, derived its name from *octo*, eight, and *imber*, a shower of rain.

November was derived from *novem*, nine, and *imber*, a shower of rain.

December, as the name implies, was the tenth month of the calendar of Romulus; and, as in the case of the three preceding months, still retains the name assigned to it, notwithstanding its change in the numerical order of the months.

Will you now state the origin of the names to the days of the week?

The week was unknown to the ancients of the classic ages, till it was gradually adopted, along with Christianity, under the later emperors. The arrangement of the heavenly bodies, according to their distances from the earth, is in this order: Saturn, Jupiter, Mars, the Sun, Venus, Mercury, the Moon; and it was a principle of the ancient astrology that these planets presided in succession over the hours of the day, and from which the Latin designations given to the days of the week have been derived; and from these have been formed the modern names used in different countries, either by literal translation, or, in the Teutonic tongues, by the substitution, in some cases, of the corresponding deity of northern paganism for the classical god.

Sunday is so called, because it was anciently dedicated to the worship of the sun.

Monday means literally the *day of the moon*.

Tuesday was dedicated to *Tuisco*, the Mars of our Saxon ancestors, the deity that presided over combats, strife, and litigation. Hence, in England Tuesday is assize day; the day for combat, or commencing litigation.

Wednesday is so called from Wodin, or Odin, a deity or chief among the northern nations of Europe.

Thursday was named by the Saxons from *Thor*, the old Teutonic god of thunder.

Friday is from *Frea* or *Friga*, a goddess of the old Saxon mythology.

Saturday means simply Saturn's day, the name being derived from the deity of that name.

At what time was the practice of dating from the Christian era first introduced?

The Christian era was first used about the year 527 by by Dionisius, surnamed "Exiguus," but better known as Denys le Petit, a monk of Scythia and a Roman abbot, in consequence of which it is sometimes called "Recapitulatio Dionisii." It was not introduced into Italy until the sixth century, and, though first used in France in the seventh, it was not universally established there till about the eighth century. An instance of the use of the Christian era in England is supposed to have occurred as early as the year 680; it was generally adopted in the eighth century, and it was ordained by the Council of Chelsea, in July, 816, that all bishops should date their acts from the year of the incarnation of our Saviour. In Spain, the Christian era, though occasionally adopted in the eleventh, was not uniformly used in public instruments until after the middle of the fourteenth century, nor in Portugal until about the year 1415. In the Eastern Empire, and in Greece, it was not universal until after the capture of Constantinople by Mahomet II. in 1453.

The years of the Christian era are described in ancient documents as the years "of Grace," of "the Incarnation," of "our Lord," of "the Nativity," of "the Circumcision," and "annus Trabeationis."

What was the dollar mark ($) derived from?

The derivation is uncertain; some say that it comes from the letters U S; others, that it is derived from the Spanish word *pesos*, dollars. The more probable explanation is, that it is a modification of the figure 8, and denotes a piece of eight reals, or, as the dollar was formerly called, a *piece of eight*. It was then designated by the figures 8/8.

What is Relievo?

In sculpture, that species of carving or chiselling in which the figures are engraved on or rise from a ground. There are three sorts—*basso-relievo*, or bas-relief, in which the figures have a small projection from the ground on which they are sculptured; *mezzo-relievo*, in which the figures stand out about half their natural proportions; and lastly, *alto-relievo*, in which the figures stand completely out from the ground, attached to it only in a few places.

Will you explain some of the common Abbreviations?

B. A., Bachelor of Arts; Bart., Baronet; B. D., Bachelor of Divinity; D. D., Doctor of Divinity; D. C. L., Doctor of Civil Law; F. R. S., Fellow of the Royal Society; G. C. B., Knight of the Grand Cross of the Bath; K. C., Knight of the Crescent; K. C. B., Knight Commander of the Order of the Bath; K. G., Knight of the Order of the Garter; LL. D., Doctor of Laws; M. A., Master of Arts; M. D., Doctor of Medicine; R. A., Royal Academician; A. D., the year of our Lord; i. e., that is to say; nem. con., without contradiction; pro tem., temporarily; ult., the last month; viz., namely.

What are the different names of Ships, or sailing vessels?

Ship is a general name for all great vessels with sails, fit for navigating the sea, except galleys, which go with oars and smack sails.

MERCHANT SHIPS are estimated by their burden, that is, by the number of tons they bear, each ton reckoned twenty cwt. The estimate is made by gauging the hold, which is the proper place of loading. A vessel is said to draw ten or fifteen feet of water when it sinks so deep under water, being loaded. A vessel is said to be of three hundred or four hundred tons when it will carry that weight, or when immerged in water it passes the space of three hundred or four hundred tons of water.

Ships of war are again divided into several orders, called *rates:* thus, a three-decked ship is called a first and second rate; a frigate, or two-decked ship, third, fourth, and fifth rate; a one-decked ship, sixth-rate; a bomb-vessel, a fire-ship, a ketch, a machine-vessel, a smoker.

A MAN-OF-WAR, first-rate, has its gun-deck from 159 to 174 feet in length, and from forty-four to fifty feet broad; contains from 1,313 to 1,882 tons; has from 706 to 800 men; and carries from ninety-six to 110 guns.

A FRIGATE is a two-decked ship, of the third, fourth, and fifth rate. Third-rates have their gun-decks from 153 to 165 feet long; and from thirty-seven to forty broad. They contain from 871 to 1,262 tons; carry from 389 to 476 men, and from sixty-four to eighty guns. The other rates are proportionably less. The sixth-rates have their gun-decks from eighty-seven to ninety-five feet long, and from twenty-two to twenty-five feet broad. They contain from 152 to 256 tons; carry from fifty to 110 men, and from sixteen to twenty-four guns. New-built ships are much larger and better than the old ones of the same rate; whence, in the double numbers, the larger express the proportions of the new-built ships; the less, those of the old ones.

YACHT, or YATCH, from the Dutch, *iatcht* (signifying hunting), a kind of vessel commodiously contrived and adorned, for private use. It is furnished with masts and sails; has one deck; burden, from thirty to 160 tons.

BRIGANTINE. A small, flat, open vessel; goes with sails and oars, and is either for fighting or giving chase. Brigantines are principally used by the Corsairs, all the hands on board being soldiers, and each having his musket ready under his oar. There are usually twelve or fifteen benches on a side for the rowers, a man and an oar to each bench. Corsairs are pirates, particularly in the Mediterranean, who plunder merchants' vessels without commission from any prince.

BRIG is a vessel with two masts, chiefly used in commerce, and carrying from 100 to 200, or even 300 tons' burden.

CLIPPERS are a class of vessels built especially for fast sailing. Clipper-ships are narrower in the beam and sharper in the bows than the usual form.

SLOOPS, or SHALLOPS, are tenders on the men-of-war, burden about sixty tons, and carrying about thirty men. They are light, small vessels, with only a small mainmast, foremast, and lug sails, to haul up and let down on occasion.

FIRE SHIPS are filled with artificial fireworks, and sent in amongst the enemy's ships.

BOMB-VESSELS have sometimes three masts and square sails, but also often ketch fashion, with one mast and mizzen.

BOMB-KETCH is for the use of mortars at sea; it is a small vessel, strengthened with large beams.

A BILANDER is seldom above twenty-four tons, and can lie near the wind.

CUTTER. A small vessel, furnished with one mast, and rigged as a sloop. Many of these are used in an illicit trade.

HULKS are large vessels, having their gun-decks from 113 to 150 feet long, and from thirty to forty feet broad; they will carry from 400 to 500 tons. A hulk is an old ship cut down to the gun-deck, and fitted with a large wheel for careening.

HOY. A small vessel or bark, whose yards are not across, nor the sails square, like those of ships, but the sails like a mizzen, so that she can sail nearer the wind than a vessel with cross sails can do.

SMACKS are vessels with but one mast, and sometimes are employed as tenders on a man-of-war; they are also used for fishing upon the coasts.

CARTEL, an agreement between two states, for the exchange of their prisoners of war. Cartel-ship is one commissioned in time of war to exchange the prisoners of any two hostile powers, etc.

GALLEY is a low-built vessel, going with oars and sails, chiefly used by the states bordering on the Mediterranean. Galleys have usually twenty-five or thirty benches of oars on each side, and four or five galley-slaves on each bench. The galley carries a large gun, two bastard pieces, and two small pieces. It is usually from twenty to twenty-two fathoms long, three broad, and one deep, and has two masts, which may be struck or lowered at pleasure.

CONVOY signifies one or more vessels of war, appointed to conduct a fleet of merchants' ships, serving as a watch and shelter from the insults of enemies; though sometimes by a convoy is implied the fleet of merchant ships bound to any particular port or place of rendezvous.

SQUADRON of ships, a division or part of a fleet commanded by a commodore. The number that form a squadron is not fixed. A small number in a body and under one commander may make a squadron. If the ships are numerous they are sometimes divided into three squadrons, and each squadron may be again divided into three divisions.

PRIVATEERS are a kind of private ships of war fitted out by private persons at their own expense, who have leave granted them to keep what they can take from the enemy, allowing the admiral his share.

BARGE, a kind of state or pleasure boat, or for the purposes of merchandise, used chiefly in the navigation of rivers.

Who invented the Alphabet?

It has been ascribed to a Phœnician. Previous to this invention, pictures or hieroglyphics were used to record events; and letters were, probably, a generalization of these. At this day the Chinese have no letters, but have two hundred and fourteen keys to classes of words, distinguished by the number of strokes combined in each. The English language has twenty-six letters; the French twenty-three; Hebrew twenty-two; Greek twenty-four; the Latin twenty-two; the Arabic twenty-eight. The figures used in arithmetic are a universal character, and many attempts have been made by the learned, to introduce a universal character into language, but at present there are two hundred or three hundred various alphabets.

What are the Cardinal Virtues?

Justice, Prudence, Temperance, and Fortitude.

The word cardinal in a general sense signifies principal or pre-eminent; it is formed of the Latin word *cardo*, a hinge, agreeably with the common expression, in which it is said of an important matter that every thing *turns* upon it. The *cardinal signs* in astronomy, are aries, libra, cancer, and capricorn. The *cardinal points* of the compass, north, south east and west. *Cardinal numbers* are the numbers one, two, three, etc., which are undeclinable, in opposition to the ordinal numbers, first, second, third, etc.

What is a Windlass?

A common mechanical power, by which weights are raised, water generally drawn out of a well. As power is as velocity, and as the hand at the winch makes a larger circle than the cylinder round which the rope coils, so the power is proportionally increased. Thus, if the hand performs a circle of six feet, while the cylinder performs but one foot, so the power of the hand, friction excepted, is increased six times.

What are Planets?

The word planet is from the Greek, *planas*, to wander. The planets are celestial bodies which revolve around the sun, and derive their name from their *motion* or *revolution*, in distinction from the fixed stars, and are distinguished from the latter by their not twinkling.

The planets are sometimes called *primary* planets, in distinction from the bodies called secondary planets, moons, or satellites, which revolve about some planet as their centre, and with that revolve about the sun. There are eleven primary planets and eighteen secondary planets. The secondary planets are also denominated satellites, from *satelles*, signifying one who follows and serves another.

Will you name the primary planets.

Mercury, Venus, the Earth, Mars, Vesta, Ceres, Pallas, Juno, Jupiter, Saturn, and Herschel or Uranus. The earth has one satellite, the moon; Jupiter, four; Saturn, seven; Uranus, six.

Mercury, the nearest planet to the sun, is a globe 3,140 miles in diameter, distance from the sun, thirty-seven millions, period of revolution, eighty-eight days. It is seldom visible. The matter of Mercury is of great density, equals lead in weight, so that a human being placed on its surface, would scarcely be able to stir.

Venus is 7,800 miles in diameter, nearly the size of the earth; distance from the sun, sixty-eight millions; time of revolution, 225 days. It is visible only in the morning and evening—one of the most brilliant and beautiful of all the stellar bodies.

The Earth, the third planet in order, is 7,902 miles in diameter; distance from the sun, ninety-five millions of miles.

Mars is a globe of 4,189 miles in diameter—a little more than half that of the earth. Its distance from the sun is one hundred and forty-two millions of miles; its period of revolution, 686 days.

Vesta, Ceres, Pallas and Juno, are four small globes revolving between the orbits of Mars and Jupiter. Vesta revolves around the sun in three years and sixty-six days; its distance is two hundred and twenty-five millions; its bulk is only one fifteen-thousandth of the bulk of the earth, with a surface not exceeding that of the kingdom of Spain.

Juno is 1,425 miles in diameter; its orbit is the most eccentric of all the planets, being 253,000,000 miles from the sun at the greatest, and only 126,000,000, at the least distance.

Ceres revolves around the sun at a distance of 260,000,000, in four years, seven months, and ten days. Its diameter has been variously estimated from 1,624 to 160 miles in diameter.

Pallas is 2,090 miles in diameter; mean distance from the sun, 266,000,000 of miles; period of revolution, four years, seven months, and eleven days.

Jupiter is the largest of all the planets. Its diameter is nearly eleven times that of the earth, or 89,170 miles. The density of Jupiter is only a fourth that of the earth, or about the lightness of water. A human being transferred to it would be able to leap thirty or forty feet in the air. It revolves around the sun at a distance of 490,000,000 of miles in 4,330 days, or nearly twelve years.

Saturn is the most remarkable of all the planets, being surrounded by a ring, and attended by seven satellites. It is 79,042 miles in diameter, being the second of the planets in size; it revolves around the sun at a distance of 900,000,000 of miles, in a period of about twenty-nine and a half of our years. The matter of Saturn is one-eighth of the density of our earth.

Uranus, or *Herschel*, the remotest planet known in the solar system, is a globe of 35,112 miles in diameter, revolving around the sun once in eighty-four of our years, at a distance of 1,800,000,000 of miles. It was discovered in 1781 by Sir William Herschel.

What is the size of the Sun?

The sun is 882,000 miles in diameter, or 1,384,472 times the bulk of the earth. It has been surmised that the sun is a dark body, enveloped in an atmosphere calculated for giving out heat and light, and the spots in the sun are produced by slight breaks or openings in that atmosphere, showing the dark mass within. The matter of the sun is only one-third in density to that of our planet, or little more than the density of water.

What are the Stars?

Suns resembling our own, but diminished to the appearance of a mere speck of light by the great distance at which they are placed. It is supposed that they are centres of light and heat to systems of revolving planets, each of which may be presumed to be the theatre of beings who in form bear some analogy to those which exist upon earth.

Stars are of different degrees of brilliancy, and are classed under different *magnitudes*, not as to size, for none of them present a measurable disc, but with a regard to the quantity of light flowing around them. Thus there are stars of the first, second, and third magnitude, and so on.

What is the distance of the Stars from our earth?

From what can be judged by computation and observation, it is concluded that none of the fixed stars can be a less distance than 32,000,000,000,000 of miles from us, which is further than a cannon-ball would fly in 7,000,000 years.

Sir John Herschel tells us, that there are stars so infinitely remote as to be situated at the distance of twelve millions of millions of miles from our earth; so that light, which travels with the velocity of twelve millions of miles in a minute, would require two millions of years for its transit from those distant orbs to our own; while the astronomer who should record the aspect of mutations of such a star, would be relating, not its history at the present day, but that which took place two millions of years gone by.

Do the fixed stars shine with their own light?

As they are much further from the sun than the remotest planet, and yet appear to shine much brighter than such planet, it is evident they cannot borrow their light from the same source.

What is the Milky Way?

This belt of whitish lustre, when examined by the telescope, is found to consist entirely of stars scattered by millions, as Herschel describes them, like glittering dust, on the black ground of the general heavens. The ancients formed the mean idea of this light that it was the milk spilt by the nurse of Mercury, one of the deities; and hence its name. The average magnitude of these stars is about the tenth or the eleventh, and hence their invisibility to the naked eye.

What is Capillary attraction?

Capillary is from *capillà*, a Latin word for hair; and capillary attraction is water or any other fluid drawn up between the threads or pores of a substance. If a piece of sponge or a lump of sugar be placed so that its lowest corner touches the water, the fluid will rise up, and wet the whole mass. If the end of a towel happens to be left in a basin of water, it will empty the basin of its contents. It is this kind of attraction which is supposed to be one of the causes of springs of water in the earth. The water creeps up by capillary attraction through porous beds of sand, small stones, and crevices of rocks, and in this manner reaches the surface even at great heights.

What is the attraction of Cohesion?

That force which keeps the particles of matter together in bodies or masses. It is a fundamental law of nature that every atom or particle of matter has a tendency to approach or to be attracted toward another atom or particle. This power of mutual attraction pervades all material things; but is of different kinds. There is the attraction of gravitation; chemical attraction; magnetic attraction; capillary attraction, and attraction of cohesion. This last acts only when particles of matter touch each other; it may be described as the quality of nature which causes matter to cohere or stick together. It is much stronger in some bodies than in others; it is stronger in the metals, weakest in the fluids, and in the air and gases almost entirely wanting.

Chemical attraction is the chemical affinities of different kinds of matter; *magnetic attraction* that which causes the magnetic needle to point continually toward the poles of the earth. There is also *electrical attraction*, which is excited by friction in certain substances.

The *attraction of gravitation* tends to force masses toward each other to form others of still greater dimensions. The force of attraction increases in proportion as bodies approach each other, and by the same law it must diminish as they recede from each other.

What is a Kaleidescope?

An optical instrument invented by Sir David Brewster, and consisting of a tube with slips of glass so arranged in the interior that small beads, pieces of colored glass, and similar substances, are thrown into an endless variety of shapes, and are very useful in suggesting patterns to cotton-printers, and others who manufacture figured patterns.

What is a Billion?

A million times a million. It cannot be counted, however easy it may be to write it. You can count 160 or 170 a minute, but let us even suppose that you go so far as 200 in a minute, then an hour will produce 12,000; a day, 288,000; and a year, or 365 days, 105,120,000. Supposing that Adam, at the beginning of his existence, had begun to count, had continued to do so, and was counting still, he would not, even now, according to the usually supposed age of our globe, have counted nearly enough. For, to count a billion, he would require 9,512 years, 34 days, 5 hours, and 20 minutes, according to the above rule.

What are Lightning Conductors?

In a report made to the English Parliament in 1855, by Sir William Snow Harris, he thus refutes the fallacy of the vulgar and unphilosophical assumption that lightning-rods "attract" the lightning, and so act as efficient safeguards: it is proved by an extensive induction of facts and a large generalization in the application of metallic conductors, that metallic substances have not exclusively in themselves any more attractive influence for the agency of lightning than other kinds of common matter; but that, on the contrary, by confining and restraining the electrical discharge within a very narrow limit, the application of a small rod or wire of metal to a given portion of a building is, in reality, highly objectionable. Besides, the application of an ordinary lightning-rod is of a very partial character: it has small electrical capacity, and is very often knocked to pieces by heavy discharges of lightning. To secure such a building as the New Palace at Westminster against lightning, Sir W. Snow Harris considers it requisite to complete the general conductibility of the whole mass, and so bring it into that passive or non-resisting state which it would assume in respect of the electrical discharge, supposing the whole were a complete mass of metal; by which means a discharge of lightning, in striking upon any given point of the building, would have, through the instrumentality of capacious electrical conductors, unlimited room for expansion upon the surface of the earth in all directions to which, by a law of nature, the discharge is determined.

TRAL COLLECTION

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